SOUTHERN COOPERATIVE SERIES
RESEARCH BULLETIN 300

FEBRUARY 1985

U. S. Grain Marketing System for the 1990's: Alternative Policy Scenarios

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Alabama, Arkansas, Georgia, Illinois, Kentucky, Louisiana, Mississippi,
Ohio, and Tennessee, in addition to TVA and USDA, cooperating

The Ohio State University
Ohio Agricultural Research and Development Center
Wooster, Ohio **Research Bulletin 1169**

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AGDEX 848-110

2-85-1.6M

FOREWORD

This publication is one of a series being prepared as a contribution to Southern Regional Research Project S-176, Interregional Marketing Systems for Grains and Soybeans.

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PREFACE

This report fulfills part of the objectives undertaken by the Southern Regional Research Project S-176, Interregional Marketing Systems for Grains and Soybeans. The work was initiated by a modeling subcommittee whose members included Lowell D. Hill, University of Illinois; Joe W. Free, Tennessee Valley Authority; Harry Hall, University of Kentucky; Travis Phillips and Lanny Bateman, University of Mississippi; and Dean Baldwin, The Ohio State University.

The authors give special thanks to Mrs. Karlene Robison for her typing effort, to Alan Tumblin who helped prepare the input data for the model, to Jill Loar for word processing, to Janice Christensen for the art work, and to Kathy Nolan for reproduction. Without their dedicated assistance, we could not have adequately prepared this manuscript.

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U. S. Grain Marketing System for the 1990's: Alternative Policy Scenarios

E. DEAN BALDWIN and DONALD W. LARSON[1]

INTRODUCTION

In the 1970's, a dynamic U. S. grain marketing system emerged in response to major changes in its components. Changes occurred in the amount of grain (corn, soybeans, and wheat) produced, quantity of grain traded in domestic and export markets, transportation technologies, and U. S. trade policy. Grain handling capacity increased at production and export locations. Truck, rail, and barge services expanded to meet transportation needs, and grain flows to export markets increased relative to grain flows to domestic markets (5, 9, 10). At the same time, international trade agreements and embargoes created an uncertain business environment for trading commodities.

These changes were unexpected and caused agribusinesses to misallocate resources. Misallocation resulted in shortages of grain, grain handling facilities, and transportation services during the 1970's and surpluses during the 1980's. Surplus facilities created problems of asset fixity because facilities could not be used for other purposes. Shortages of facilities, on the other hand, prevented firms from providing sufficient services to facilitate the unexpected increases in the supply and demand for grain.

Although the exact changes which will influence investment decisions in the grain industry in the 1990's are unknown, it is likely that changes in grain production, domestic and export demand, and the cost and availability of transportation services will be prominent factors. Since these factors are influenced in part by public policy decisions, the purpose of this paper is to present to policy makers the impact of a select set of policy changes on the U. S. grain marketing system. It is important that policy makers be informed about alternative scenarios so that long-term, rather than short-

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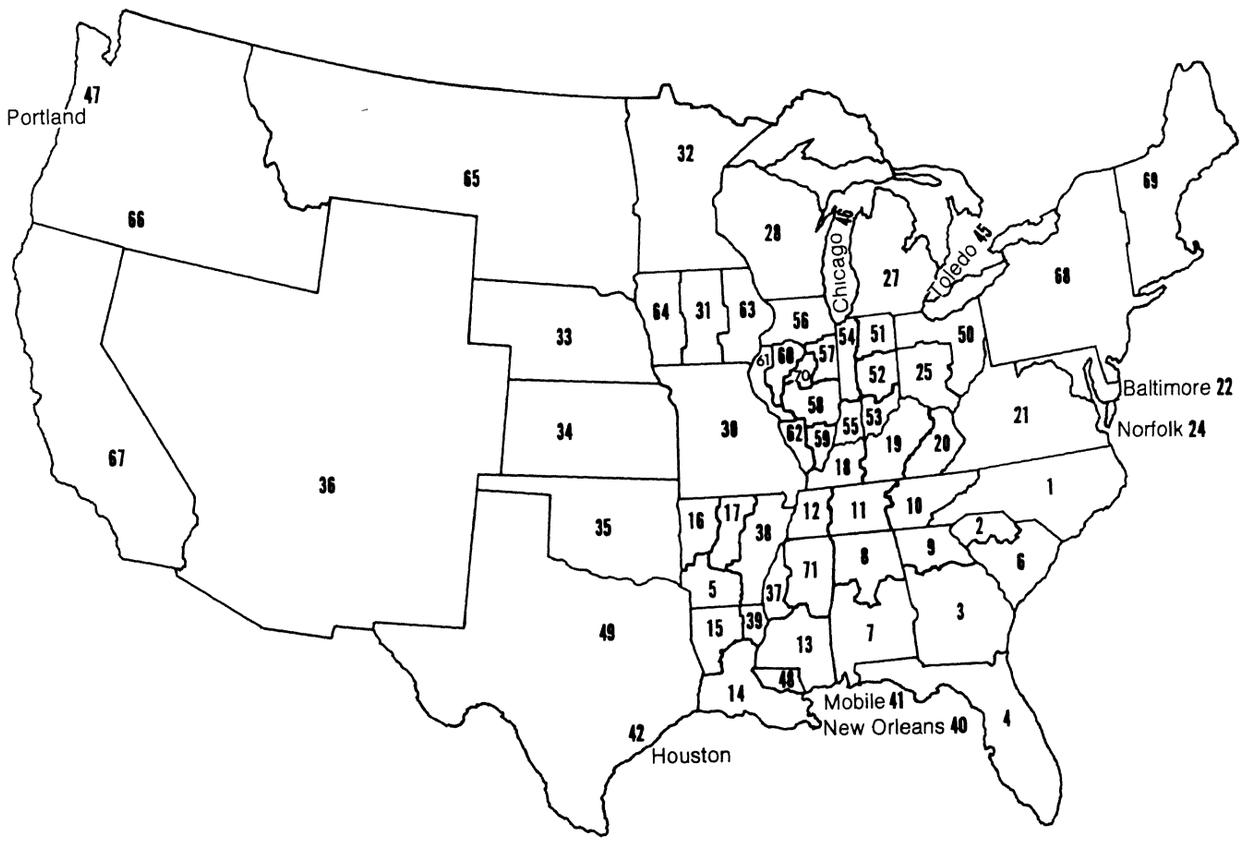

FIG. 1.—Map of S-115 areas. Numbers are market areas used in S-115 study.

term, policies affecting grain markets will be initiated. Long-term policies are desirable because they enable agribusinessmen to make improved investment decisions.

METHODOLOGY

To help analyze the impact of policy changes and technologies on the U. S. grain marketing system, grain marketing regions and export points located on the Great Lakes, the Gulf Coast, and the Atlantic and Pacific coasts are identified (Fig. 1). The criteria used to identify each marketing region within a state or for a group of states are: types of grain produced, volume of grain produced, historic grain flow patterns, transportation modes available, and numbers and types of elevators and processing firms.

Market structure data from a 1977 industry survey identified numbers and types of elevators and manufacturing firms in each region (7). Grain flow data from the 1970 and 1977 grain industry surveys identified probable grain flow patterns and routes (5, 9, 10). One location, a city or town, in each region was identified as a transportation point. Personnel from the Tennessee Valley Authority (TVA) used the transportation route and point data to calculate rail, truck, and/or transport rates for grain among the marketing regions and to export points (4).

The above data are incorporated into a linear programming (L. P.) model to analyze the impact of selected policy changes on the U. S. grain marketing system. The L. P. model, like all of its predecessors, is solved within the theoretical framework of perfectly competitive markets.[2] The objective function minimizes the total cost of assembling, storing, processing,

[2]The concept of perfect markets is discussed by Sosnick (13)

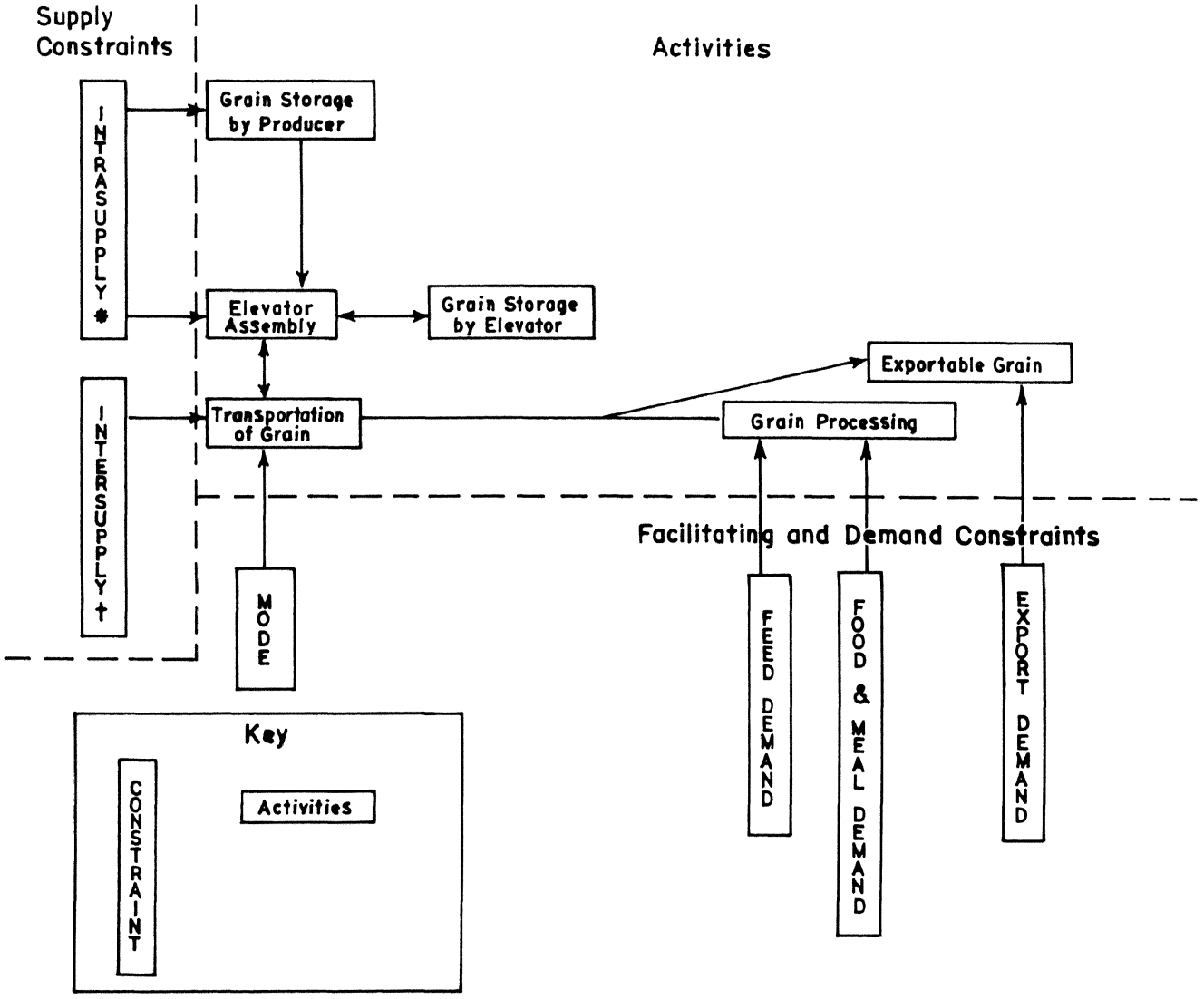

FIG. 2.—National grain model flow diagram illustrating generalized activities and constraints.

and transporting grain by 6 transportation options from 59 origins to 59 destinations[3] and to 8 export points for 3 commodities (corn, wheat, and soybeans) in 2 time periods[4] (Fig. 2). In the model, different transportation options (single rail car, three car, ten car, unit train, truck, and barge) and combinations of these options transport grain among the regions and to the export points. For each region, the model contains one representative farm storage firm, four different elevator types, three different feed manufacturers or feed mills, and one corn processor, wheat miller, and soybean processor.[5] Each of these firms can store grain during the two time periods and can transport grain to other firms and to other regions. Since the storage capacity per region and the supply of transportation services are not constrained, grain movements between time periods and across regions are limited by the respective market regions' surpluses and disappearances.

Grain production, disappearance, and surpluses or deficits for each region are identified from the grain projection analysis developed by Lazarus, Hill and Thompson (8) and from secondary sources (3). If disappearance of a grain in a region exceeds the production of that grain, the marketing region is defined as a deficit area. In contrast, when the production of a grain exceeds its disappearance, the marketing region is defined as a surplus area. The grain deficits or surpluses for each respective region are constrained in the model, and firms endogenously ship grain from surplus regions to deficit areas and to export points. Exports are also constrained in the model and are allocated among ports based on historic percentage shares (5, 9, 10). Movements of grain among surplus and deficit regions and export points are endogenously determined by transportation, assembly, and storage costs.

Since economic activities such as drying of grain and the movement of grain within a region to meet local disappearance are not directly influenced by the national grain market, they are not included in this analysis. The specific details and assumptions underlying the model are described in a Southern Regional Research Bulletin, Mathematical Specifications and an L. P. Matrix Generator for Grain Marketing Models (2).

[3]In this analysis, each origin can be a destination and each destination can be an origin. Because grain does not flow from traditional grain deficit areas to grain surplus areas, transportation routes and rates were not specified for all options (4).

[4]Time period 1 includes the wheat, corn, and soybean harvest (July to December), while time period 2 includes the winter livestock feeding period (December to June).

[5]The firm types were specified by representatives from the S-115 committee and from secondary sources. Although only four elevator types exist per region, for example, the firms' characteristics may be unique among regions. Definitions for the firm types are listed in a conference paper (7).

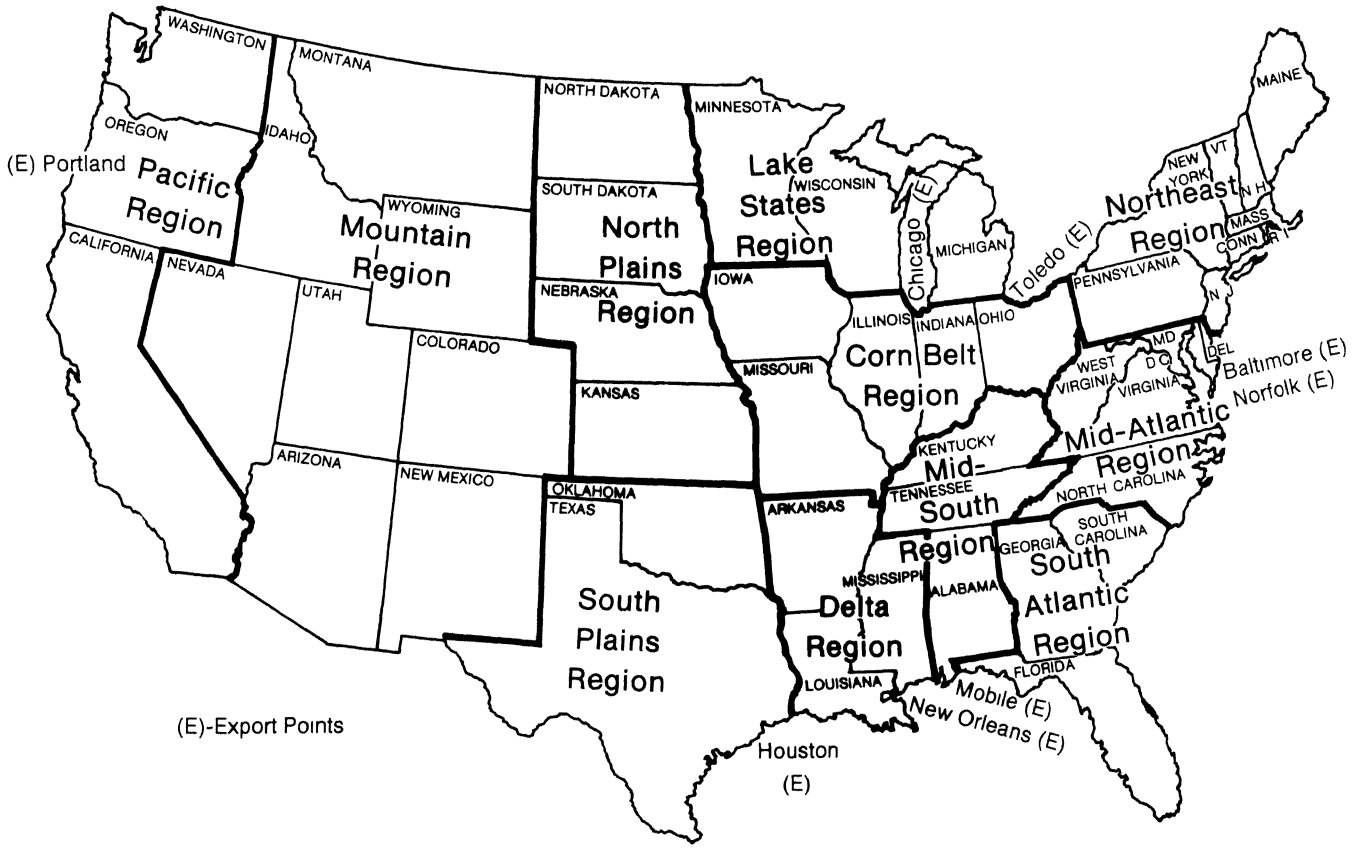

FIG. 3.—Eleven production regions and eight export points.

Although the L. P. model reports output for each policy for all 59 marketing areas and 8 export points, the results for the marketing areas are aggregated into 11 production regions in order to effectively discuss and analyze each policy scenario (Fig. 3). These production regions effectively represent specialized grain production areas, livestock regions, and surplus and/or deficit grain areas. For example, the North Plains region is a major wheat producing area and the South Atlantic region is a grain deficit area which feeds large quantities of grain to livestock.

Finally, the results reported for the baseline model represent what *could* occur in 1989/90, rather than what *will be* the final outcome. The introduction of each policy scenario then modifies the outcomes of the baseline model illustrating the impact of the selected policy on the national grain marketing system. Since this analysis examines what could occur in the future, alternative sets of assumptions, scenarios, and input data can be entered into these models, an obvious strength of this analysis. The remainder of this bulletin presents the selected policy scenarios, assumptions and exogenous data for each scenario, and the results, conclusions, and implications.

SELECTED POLICY SCENARIOS

The following baseline model and ten alternative policy scenarios are analyzed for 1990. The baseline model or estimate is used throughout the analysis as the norm for comparative purposes and is a 1989/90 grain production-disappearance estimate. The next three are export scenarios: 2) a 64% increase (a decrease in domestic grain disappearances of 50%) in the volume of grain exports relative to exports for the baseline scenario (export scenario); 3) the opening of three super export points: one each on the East Coast, the West Coast, and the Gulf (super port scenario)[6]; and 4) a 322% increase in the volume of grain exports via the West Coast relative to exports via the West Coast for the baseline scenario (Pacific Coast scenario).

In addition to the above, four transportation scenarios follow: 5) a 20% increase in rail rates for the transportation of grain from surplus to deficit regions and to export points (20% rail rate increase scenario); 6) a 20% increase in barge rates for the transportation of grain from surplus to deficit regions and to export points (20% barge rate increase scenario); 7) a 30% increase in barge rates (30% barge rate increase scenario); and 8) a rail abandonment policy in which single rail car shipments are eliminated in the Corn Belt (rail abandonment scenario).

The impact of converting corn into alcohol is also analyzed in the following two scenarios: 9) a 15% increase in corn production relative to the baseline scenario to produce the desired alcohol (corn production increase and alcohol scenario); and 10) a 38% decrease in

[6]A super port is defined as a port which has the capacity to load vessels with 100,000 tons or more capacity In this option, ports such as those on the Great Lakes which cannot handle vessels of that size are closed.

TABLE 1.—Corn, Wheat, and Soybean Production for 1978 and Production Estimates for 1989* for the U. S. and 11 Production Regions (Millions of Bushels and Percentage Change, 1989/90).

Regions	Corn		Wheat		Soybeans		Total	
	1978	1989	1978	1989	1978	1989	1978	1989
	(Million bu)							
Northeast	169.1	210.0	11.9	24.6	8.6	11.1	189.6	245.7
Percent Change	100	124	100	207	100	129	100	130
Mid-Atlantic	250.5	350.5	16.7	40.6	67.6	152.6	334.8	543.7
Percent Change	100	140	100	243	100	226	100	162
South Atlantic	124.5	218.5	6.8	13.7	71.3	194.9	201.6	427.1
Percent Change	100	176	100	201	100	273	100	211
Mid-South	190	275.5	16.2	37.3	142.1	331.1	348.9	643.9
Percent Change	100	145	100	230	100	133	100	185
Delta	12.1	23.8	13.7	35.1	265.5	645.7	291.3	704.6
Percent Change	100	197	100	256	100	243	100	242
Corn Belt	3,861.2	5,025.3	141.3	305.5	1,009.4	2,049.0	5,011.9	7,379.8
Percent Change	100	130	100	216	100	203	100	147
Lake States	1,095.5	1,349.1	112.8	223.1	168.2	230.0	1,376.5	1,812.2
Percent Change	100	123	100	207	100	137	100	132
North Plains	1,084.7	1,672.1	739.7	1,239.3	85.3	163.7	1,909.7	3,075.1
Percent Change	100	154	100	168	100	192	100	161
South Plains	148.7	209.0	199.8	397.8	24.7	39.0	373.2	645.8
Percent Change	100	141	100	199	100	158	100	173
Mountain	100.5	93.2	308.1	461.1			408.6	554.3
Percent Change	100	93	100	150			100	136
Pacific	44.5	73.0	231.7	316.8			276.2	389.8
Percent Change	100	164	100	137			100	141
U. S. Total	7,081.9	9,500.0	1,798.7	3,104.9	1,842.7	3,817.1	10,723.3	16,422.0
Percent Change	100	134	100	173	100	207	100	153

*Average annual percentage change in U. S. production for the 1969 to 1979 period extrapolated to 1989. U. S. production is allocated among states and regions based on percentage shares published by Lazarus, Hill, and Thompson (8).

corn exports and a static corn production level relative to the baseline scenario to produce the desired alcohol (export reduction and alcohol scenario). Finally, the 11th scenario examines a 445% increase in the volume of stored grain (storage scenario).

Baseline Scenario

Grain production and disappearance estimates for the baseline scenario are calculated from the average annual percentage change in grain production and disappearance for the 1969 to 1979 period and are extrapolated to 1989/90. The separate estimates for grain production, exports, and domestic disappearance result in modest increases in grain production and total disappearances relative to past USDA-NIRAP projections and an alternative set of estimates which were extrapolated to 1989/90 (1). The baseline estimates represent moderate increases because these estimates are greater than the NIRAP projections and are less than the alternative set of estimates prepared by Baldwin and Larson (1).

Based on the average annual percentage change estimates, 1989/90 U. S. grain production and domestic disappearance data are exogenously allocated to the selected marketing regions based on their historic percentage shares (8). In each respective region, a portion of this grain is consumed on the farm or by processors within the region in which it is produced. This locally consumed grain is not traded in the national market and is not included in the national grain model. Total exports are constrained at the 1990 estimated level and carryover (storage) is endogenously determined.

Corn production for the baseline estimate is estimated at 9.5 billion bushels in 1989, a 34% increase over the 1978 production level and a 13% increase over the 1982 record corn harvest (Table 1). Wheat production is also estimated to increase to 3.1 billion bushels in 1989 or an increase of 73% above the 1978 production level and 11% above the 1982 record harvest. Finally, soybeans are estimated at 3.8 billion bushels in 1989, a 107% increase above the 1978 production level and 67% above the 1982 record. Total grain production is estimated at 16.4 billion bushels, a 53% increase relative to 1978 and 22% above the 1982 record.

For this alternative, it is estimated that by 1990 5.1 billion bushels of surplus corn, 2.6 billion bushels of soybeans, and 2.1 billion bushels of wheat will be traded annually in the national market (Tables 2, 3, and 4). In Table 5, it is estimated that 9.8 billion bushels of surplus grain will be traded nationally—1.8 billion will move from surplus regions to deficit regions, 7.2 billion bushels will move to export points, and 802 million bushels will be stored. The respective surplus and deficit production regions are identified in Tables 2, 3, and 4 and in Figure 3.

Export Scenario

For the export scenario, it is assumed that the domestic grain disappearance in each region would decrease by 50% relative to the level in the baseline estimate, while grain production would equal the baseline estimate. Because of the decrease in domestic grain disappearances, the number of grain surplus producing regions increases, the number of grain deficit regions decreases, and the number of bushels of grain exported increases significantly (Tables 2, 3, and 4). The added exports are allocated to the eight export points based on their historic shipping patterns.

Based on these assumptions, it is estimated that by 1990 7.2 billion bushels of surplus corn, 2.9 billion bushels of surplus soybeans, and 2.7 billion bushels of surplus wheat will be traded annually in the national market (Tables 2, 3, and 4). It is estimated in Table 5 that 12.9 billion bushels of grain will be traded nationally, an increase of 32% relative to the baseline estimate. In contrast to the baseline estimate, 566 million bushels of grain will be consumed in the deficit producing regions, a decrease of 69% relative to the level estimated for the baseline estimate (Table 5). Total grain exports for 1990 are estimated at 11.8 billion bushels, an increase of 64% relative to the level estimated for the baseline estimate; 558 million bushels of grain are stored for carryover into the next year. Corn shipments into deficit areas decrease to 383 million bushels relative to domestic shipments for the baseline estimate, soybean shipments into deficit areas decrease to 127 million bushels, and wheat shipments into deficit areas decrease to 56 million bushels (Tables 2, 3, and 4). Corn exports increase to 6.6 billion bushels, soybean exports increase to 2.5 billion, and wheat exports increase to 2.6 billion bushels. Since exports increase and domestic disappearances decrease, the model may endogenously determine new grain flow patterns, alternative transportation options, storage patterns or locations, and marketing and transportation costs.

Super Port Scenario

Because of technological changes in the transportation system, large super ports may be in use in 1990. A super port is defined in this analysis as a port which has the capacity to load vessels with 100,000 tons or more of grain for transfer from the United States to Europe, the Soviet Bloc, and/or Asia. For this scenario the baseline grain production, domestic grain disappearance, and total export estimates are used (Tables 1, 2, 3, 4, and 5). However, all previous Great Lakes and East Coast grain exports (Chicago, Toledo, Philadelphia, Norfolk, and Charleston) for the baseline scenario will exit the country at one super port located at Norfolk; all previous baseline estimate Gulf Coast exports (Mobile, New Orleans, and Houston) exit the country at one super port located at New Orleans; and all baseline estimate West Coast exports (Portland) exit the U. S. at one super port at Portland. The volume of grain in the surplus regions, the number of deficit regions, total exports, and the grain stored are equal to that described for the baseline estimate (Tables 2, 3, 4, and 5). Because all exports exit the country at only three locations, the model may endogenously determine new grain flow patterns, alternative transportation options, storage patterns or locations, and marketing and transportation costs.

TABLE 2.—Corn Surpluses and Deficits* for 11 Grain Production Regions, Exports for 8 Export Points, and Storage for the U. S., 1989/90.

Regions	Policy Scenarios†										
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
	Baseline Estimate‡	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
	(Million bu)										
Surplus											
Northeast		140									
Mid-Atlantic		82									
South Atlantic		88									
Mid-South		114									
Delta											
Corn Belt	3,346	4,185	3,346	3,346	3,346	3,346	3,346	3,346	3,709	2,778	3,346
Lake States	526	938	526	526	526	526	526	526	606	460	526
North Plains	1,134	1,134	1,134	1,134	1,134	1,134	1,134	1,134	1,389	1,075	1,134
South Plains		31									
Mountain											
Pacific											
Total (A)**	5,121	7,227	5,116	5,120	5,121	5,121	5,121	5,121	5,759	4,336	5,116
Deficit											
Northeast	72		72	72	72	72	72	72	169	171	72
Mid-Atlantic	67		67	67	67	67	67	67	198	198	67
South Atlantic	102		102	102	102	102	102	102	161	173	102
Mid-South	50		54	50	50	50	50	50	102	120	54
Delta	186	40	186	186	186	186	186	186	316	316	186
Corn Belt											
Lake States											
North Plains											
South Plains	182		183	183	183	183	183	183	197	197	183
Mountain	188	188	188	188	188	188	188	188	226	226	188
Pacific	262	44	262	262	262	262	262	262	439	439	262
Total (B)**	1,224	383	1,224	1,224	1,225	1,225	1,225	1,225	1,863	1,863	1,224
Export											
Baltimore	700	1,330		468	700	700	700	700	700	430	350
Norfolk	595	1,130	1,854	397	595	595	595	595	595	365	297
New Orleans	1,259	2,394	1,818	840	1,259	1,259	1,259	1,259	1,259	775	630
Mobile	350	333		233	350	350	350	350	350	213	175
Houston	208	399		140	208	208	208	208	208	128	104
Toledo	280	532		186	280	280	280	280	280	172	140
Chicago	279	532		186	280	280	280	280	280	172	140
Portland				1,224							
Total (C)	3,671	6,650	3,672	3,674	3,672	3,672	3,672	3,672	3,672	2,255	1,836
B + C	4,895	7,033	4,896	4,898	4,897	4,897	4,897	4,897	5,535	4,118	3,060
Storage [A — (B + C)]	226	194	220	222	224	224	224	224	224	218	2,056

*A region is defined as a surplus area if production within the region is greater than disappearance; a region is defined as a deficit area whenever the disappearance in an area is greater than production.

†See main text for definitions and assumptions for each scenario.

‡Average annual percentage change in U. S. production for the 1969 to 1979 period extrapolated to 1989. U. S. production is allocated among states and regions based on percentage shares published by Lazarus, Hill, and Thompson (8).

**Within each production region, one or more marketing areas (Figures 1 and 3) may be a surplus (deficit) area, even though the region is defined as deficit (surplus). Thus regional data cannot be summed to totals.

TABLE 3.—Soybean Surpluses and Deficits* for 11 Grain Production Regions, Exports for 8 Export Points, and Storage for the U. S., 1989/90.

Regions	Policy Scenarios†										
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
	Baseline Estimate‡	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
	(Million bu)										
Surplus											
Northeast											
Mid-Atlantic	110	115	110	110	110	110	110	110	110	110	100
South Atlantic	89	142	89	89	89	89	89	89	89	89	89
Mid-South	7	185	7	7	7	6	6	7	7	7	7
Delta	308	495	308	308	308	308	308	308	308	308	308
Corn Belt	1,285	1,490	1,286	1,286	1,286	1,286	1,286	1,286	1,285	1,285	1,286
Lake States	203	216	203	203	203	203	203	203	203	203	203
North Plains	96	103	97	97	97	97	97	97	96	96	97
South Plains	24	32	25	25	25	25	25	25	24	24	25
Mountain											
Pacific											
Total (A)**	2,555	2,905	2,558	2,558	2,558	2,557	2,557	2,558	2,555	2,555	2,558
Deficit** ††	433	127	433	433	433	433	433	433	433	433	433
Export											
Baltimore	43	60		29	43	43	43	43	43	43	22
Norfolk	168	231	440	112	168	168	168	168	168	168	84
New Orleans	1,153	1,586	1,446	771	1,153	1,153	1,153	1,153	1,153	1,153	576
Mobile	212	291		141	212	212	212	212	212	212	106
Houston											
Toledo	142	195		95	142	142	142	142	142	142	71
Chicago	87	120		58	87	87	87	87	87	87	43
Portland	4	5	4	630	4	4	4	4	4	4	2
Total (C)	1,809	2,488	1,890	1,836	1,809	1,809	1,809	1,809	1,809	1,809	904
B + C	2,242	2,615	2,323	2,269	2,242	2,242	2,242	2,242	2,242	1,337	904
Storage [A — (B + C)]	313	290	235	289	316	315	315	316	313	313	1,221

*A region is defined as a surplus area if production within the region is greater than disappearance, a region is defined as a deficit area whenever the disappearance in an area is greater than production

†See main text for definitions and assumptions for each scenario

‡Average annual percentage change in U S production for the 1969 to 1979 period extrapolated to 1989 U S production is allocated among states and regions based on percentage shares published by Lazarus, Hill, and Thompson (8)

**Within each production region, one or more marketing areas (Figures 1 and 3) may be a surplus (deficit) area, even though the region is defined as deficit (surplus) Thus regional data cannot be summed to totals.

††The aggregation process eliminates all deficits by region; that is, all areas become surplus grain producing regions See Table 20 for soybean processing demand by region

TABLE 4.—Wheat Surpluses and Deficits* for 11 Grain Production Regions, Exports for 8 Export Points, and Storage for the U. S., 1989/90.

Regions	Baseline Estimate‡	Policy Scenarios†									
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
		Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
	(Million bu)										
Surplus											
Northeast											
Mid-Atlantic		7									
South Atlantic		3									
Mid-South	6	21	6	6	6	6	5	6	6	6	6
Delta	31	33	31	31	31	31	31	31	31	31	31
Corn Belt	176	224	176	176	176	176	176	175	176	176	176
Lake States	149	191	149	149	149	149	149	149	149	149	149
North Plains	1,296	1,787	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296
South Plains	339	369	339	339	339	339	339	339	339	339	340
Mountain											
Pacific	31	57	31	31	31	31	31	31	31	31	30
Total (A)**	2,092	2,731	2,092	2,092	2,091	2,092	2,092	2,092	2,092	2,092	2,092
Deficit											
Northeast	67	16	67	67	67	67	67	67	67	67	67
Mid-Atlantic	10		10	10	10	10	10	10	10	10	10
South Atlantic	6		6	6	7	6	6	6	6	6	6
Mid-South											
Delta											
Corn Belt											
Lake States											
North Plains											
South Plains											
Mountain	12	1	12	12	12	12	12	12	12	12	12
Pacific											
Total (B)**	159	56	159	159	159	159	159	159	159	159	159
Export											
Baltimore	23	36		23	23	23	23	23	23	23	12
Norfolk	43	68	334	43	43	43	43	43	43	43	22
New Orleans	339	528	785	339	339	339	339	339	339	339	170
Mobile	27	42		27	27	27	27	27	27	27	13
Houston	631	983		631	631	631	631	631	631	631	316
Toledo	30	47		30	30	30	30	30	30	30	15
Chicago	7	10		7	7	7	7	7	7	7	3
Portland	570	887	551	50	569	569	569	569	570	570	285
Total (C)	1,670	2,601	1,670	1,670	1,669	1,669	1.669	1,669	1,670	1,670	836
B + C	1,829	2,657	1,829	1,829	1,828	1,828	1,828	1,828	1,829	1,829	995
Storage [A — (B + C)]	263	74	263	263	263	264	263	263	263	263	1,097

*A region is defined as a surplus area if production within the region is greater than disappearance; a region is defined as a deficit area whenever the disappearance in an area is greater than production.

†See main text for definitions and assumptions for each scenario.

‡Average annual percentage change in U. S. production for the 1969 to 1979 period extrapolated to 1989. U. S. production is allocated among states and regions based on percentage shares published by Lazarus, Hill, and Thompson (8).

**Within each production region, one or more marketing areas (Figures 1 and 3) may be a surplus (deficit) area, even though the region is defined as deficit (surplus).

TABLE 5.—Grain Surpluses and Deficits for 11 Grain Production Regions, Exports for 8 Export Points, and Storage for the U. S., 1989/90.

Regions	Policy Scenarios†										
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
	Baseline Estimate‡	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
	(Million bu)										
Surplus**											
Northeast		140									
Mid-Atlantic	110	204	110	110	110	110	110	110	110	110	110
South Atlantic	89	233	89	89	89	89	89	89	89	89	89
Mid-South	13	320	13	13	13	12	11	13	13	13	13
Delta	339	528	339	339	339	339	339	339	339	339	339
Corn Belt	4,807	5,899	4,808	4,808	4,808	4,808	4,808	4,807	5,170	4,239	4,808
Lake States	878	2,345	878	878	878	878	878	878	958	812	878
North Plains	2,526	3,264	2,527	2,517	2,527	2,527	2,527	2,527	2,781	2,467	2,527
South Plains	363	432	365	365	365	365	365	365	363	363	365
Mountain											
Pacific	31	57	30	30	30	30	30	30	31	31	30
Total (A)	9,768	12,863	9,766	9,607	9,770	9,770	9,769	9,770	10,406	8,983	9,766
Deficit**											
Northeast	139	16	139	139	139	139	139	139	236	238	139
Mid-Atlantic	77		77	77	77	77	77	77	208	208	77
South Atlantic	108		108	108	109	108	108	108	167	179	108
Mid-South	50		54	54	50	50	50	50	102	120	54
Delta	186	40	186	186	186	186	186	186	316	316	186
Corn Belt											
Lake States											
North Plains											
South Plains	182		183	183	183	183	183	183	197	197	183
Mountain	200	25	200	200	200	200	200	200	238	238	200
Pacific	262	44	262	262	262	262	262	262	439	439	262
Total (B)††	1,816	566	1,816	1,657	1,817	1,817	1,817	1,817	2,455	2,455	1,816
Export											
Baltimore	766	1,426		520	766	766	766	766	766	496	384
Norfolk	806	1,429	2,628	552	806	806	806	806	806	576	403
New Orleans	2,751	4,508	4,049	1,950	2,751	2,751	2,751	2,751	2,751	2,267	1,376
Mobile	589	666		401	589	589	589	589	589	452	294
Houston	839	1,382		771	839	839	839	839	839	759	420
Toledo	452	774		311	452	452	452	452	452	344	226
Chicago	373	662		251	374	374	374	374	374	266	186
Portland	574	892	555	2,424	573	573	573	573	574	574	287
Total (C)	7,150	11,739	7,232	7,180	7,150	7,150	7,150	7,150	7,151	5,734	3,576
B + C	8,966	12,305	9,048	8,837	8,967	8,967	8,967	8,967	9,606	8,189	5,392
Storage [A — (B + C)]	802	558	718	770	803	803	802	803	800	794	4,374

*A region is defined as a surplus area if production within the region is greater than disappearance; a region is defined as a deficit area whenever the disappearance in an area is greater than production.

†See main text for definitions and assumptions for each scenario.

‡Average annual percentage change in U. S. production for the 1969 to 1979 period extrapolated to 1989. U. S. production is allocated among states and regions based on percentage shares published by Lazarus, Hill, and Thompson (8).

**Within each production region, one or more marketing areas (Figures 1 and 3) may be a surplus (deficit) area, even though the region is defined as deficit (surplus).

††Deficits by region do not sum to the total because the aggregation process eliminates all deficits by region for soybeans (see Table 3).

TABLE 6.—Estimated Bushels of Corn Processed into Ethyl Alcohol and Gallons of Alcohol by State Production Region and the U. S., 1990.

State and Region	Bushels of Corn (000 bu)	Gallons of Alcohol (000 gal)
Maine	10,000	25,000
New Hampshire	4,000	10,000
New York	20,128	50,321
Pennsylvania	49,309	123,253
New Jersey	3,000	7,500
Maryland	12,400	31,000
Northeast	98,820	247,074
Virginia	83,828	209,570
West Virginia	400	1,000
North Carolina	46,530	116,326
Mid-Atlantic	130,758	326,896
South Carolina	41,720	104,300
Georgia	14,262	25,653
Florida	15,320	38,300
South Atlantic	71,302	178,253
Alabama	20,730	51,825
Tennessee	17,740	44,350
Kentucky	31,624	79,060
Mid-South	70,094	175,235
Mississippi	600	1,500
Louisiana	127,660	319,149
Arkansas	1,200	3,000
Delta	129,460	323,649
Ohio	48,400	121,000
Indiana	93,050	232,624
Illinois	268,538	671,343
Missouri	14,644	36,610
Iowa	138,212	345,530
Corn Belt	562,843	1,407,107
Michigan	46,800	117,000
Wisconsin	13,800	34,500
Minnesota	5,560	13,900
Lake States	66,160	165,400
North Dakota	400	1,000
South Dakota	796	1,990
Nebraska	41,410	103,525
Kansas	16,200	40,500
North Plains	58,806	147,015
Oklahoma	240	600
Texas	13,800	34,500
South Plains	14,040	35,100
Colorado	23,164	57,910
Arizona	2,200	5,500
Utah	12,700	31,750
Mountain	38,064	95,160
Idaho	8,200	20,500
Washington	70,400	176,000
Oregon	20,828	52,070
California	77,600	194,000
Pacific States	177,028	442,570
United States	1,421,786*	3,554,459*

*Does not add due to rounding and reported production of alcohol for plants which were yet to be located by state.

Source: National Alcohol Fuels Commission memo and Summary authored by James M. Childress, Executive Director, U. S. National Alcohol Fuels Commission, Washington, D. C.

Pacific Coast Scenario

The U. S. grain exports to countries in Asia and Africa may increase relative to shipments to the traditional European markets because of increases in demand in these developing countries and an increase in grain surplus in the traditional European markets. The increase in the European grain surplus reduces U. S. exports to Europe and creates formidable competition for the U. S. Because of these changes in grain demands and supplies, large quantities of grain may exit the country via the West Coast by 1990. The assumptions underlying the Pacific Coast scenario are equal to the baseline estimates, except corn exports to the West Coast are increased to 1.2 billion bushels and soybean exports are increased to 630 million bushels (Tables 2 and 3). The residual lower volume of exports is allocated to the Atlantic and Gulf Ports based on their historic percentage shares. Since 34% of all wheat exports exited the country via the West Coast for the baseline estimate, wheat exports are not increased relative to the baseline model.

The volume of grain in the surplus regions, the number of surplus regions, grain disappearance in the deficit regions, the number of deficit regions, total exports, and the grain stored are equal to that described for the baseline scenario (Tables 2, 3, 4, and 5). Because total grain exports via the West Coast increased by 386% and exports via the Atlantic and Gulf ports decreased by 33% relative to the baseline estimates, the model may endogenously determine new grain flow patterns, alternative transportation options, storage patterns or locations, and marketing and transportation costs relative to those determined for the baseline model.

Transportation Rate Scenarios

Three separate solutions are obtained by increasing rail rates by 20% and increasing barge rates by 20% and 30% above the transportation rates used in the baseline model. After thoroughly examining the shadow price coefficients, rate increases of less than 20% are not examined because such changes generate solutions which are not significantly different from the baseline solution. In addition, rail rates are not increased beyond 20% as such solutions transfer grain from the railroads to trucks rather than to barges, resulting in higher marketing costs and unrealistic long truck shipments. For the same reasons, barge rates are not increased above the 30% level because additional grain cannot be transferred onto railroads.

For these scenarios the baseline grain production, domestic grain disappearance, and total export estimates are used (Tables 1, 2, 3, 4, and 5). Also, the volume of grain in the surplus regions, the number of surplus regions, grain disappearance in the deficit regions, the number of deficit regions, and the volume of stored grain are equal to that described for the baseline model. Because of the increases in rates, solutions from these models may identify alternative transportation options, storage patterns or locations, and marketing costs.

Rail Abandonment Scenario

As railroad companies reorganize and consolidate, unprofitable rail lines are abandoned. Many, if not most, of these abandoned lines are located in the Corn Belt and are used by elevators to ship grain via the single car rate (6). Based on the findings in these prior research reports, single car shipments which originate from the Corn Belt to deficit regions and export points are eliminated for this rail abandonment scenario.

Although the baseline grain production, domestic grain disappearance, and total export estimates are used to examine the rail abandonment scenario, all single car rail shipments originating in the Corn Belt must be shipped in multi-car or train load units, trucks, and/or barges (Tables 1, 2, 3, 4, and 5). Because shipments out of the Corn Belt cannot originate via single car rates, the model may endogenously determine new grain flow patterns, alternative transportation options, storage patterns or locations, and marketing and transportation costs.

Corn Production Increase and Alcohol Scenario

Because of the energy crisis, the U. S. and state governments introduced favorable tax legislation and other subsidies to stimulate the production of alcohol from agricultural products. Some of these ethanol plants are now on line and others are being built. At the time this research was initiated, the National Alcohol Fuels Commission surveyed all potential companies which planned to build ethanol plants. Based on this survey, the Commission estimated that 226 plants would be built in 41 states and that 1.4 billion bushels of corn would be converted into 3.6 billion gallons of ethanol by the termination of this decade (Table 6). These estimates are consistent with those published in 1980 by others who were pursuing research in this area (11).

The data presented in Table 6 are allocated to the respective marketing regions (Fig. 1) to examine this scenario and the counterpart export reduction and alcohol scenario. This alters the volume of corn in the surplus regions, the number of surplus regions, the volume of corn consumed in the deficit regions, the number of deficit regions, and the volume of corn exported or stored (Table 2). Soybean and wheat production, domestic disappearances, and exports are assumed to be unchanged from those reported for the baseline scenario.[7]

For the production and alcohol scenario, it is also assumed that corn production increases to accommodate the increase in demand for corn. Annual corn production is estimated at 10.2 billion bushels in 1990, a 54% increase over the 1978 level and a 31% increase over the 1982 record harvest (Table 7). In addition, it is estimated that by 1990 three regions will produce 5.8 billion bushels of surplus corn, eight corn deficit regions will demand 1.9 billion bushels of corn, and 3.7

[7]Recently published reports indicate that soybean production will decline as corn production is increased Although this analysis assumes that adequate land is available to produce more corn, or that the yield per acre will increase, future solutions will also reduce soybean production as well

TABLE 7.—Corn, Wheat,and Soybean Production for 1978 and Production Estimates for 1989 for the U. S. and 11 Production Regions (Millions of Bushels and Percentage Change: Production and Alcohol Scenario, 1989/90).

Regions	Corn		Wheat		Soybeans		Total	
	1978	1989	1978	1989	1978	1989	1978	1989
	(Million bu)							
Northeast	169.1	241	11.9	24.6	8.6	11.1	189.6	276.7
Percent Change	100	42	100	207	100	129	100	46
Mid-Atlantic	250.5	403	16.7	40.6	67 6	152.6	334.8	596.2
Percent Change	100	61	100	243	100	226	100	78
South Atlantic	124 5	251	6.8	13.7	71.3	194.9	202.6	459.6
Percent Change	100	202	100	201	100	273	100	127
Mid-South	190.6	316	16.2	37.3	142.1	331.1	348 9	684.4
Percent Change	100	66	100	230	100	233	100	96
Delta	12.1	27	13.7	35.1	265.5	645.7	291.3	707.8
Percent Change	100	226	100	256	100	243	100	143
Corn Belt	3,861.2	5,778	141.3	305.5	1,009.4	2,049	5,011.9	8,132.5
Percent Change	100.	50	100	216	100	203	100	62
Lake States	1,095.5	1,550	112.8	233.1	168.2	230.0	1,376.5	2,013.1
Percent Change	100	41	100	207	100	137	100	46
North Plains	1,084.7	1,921	739.7	1,239.3	85.3	163.7	1,909.7	3,324.0
Percent Change	100	77	100	168	100	192	100	74
South Plains	148.7	240	199.8	397.8	24.7	39	373.2	676.8
Percent Change	100	61	100	199	100	158	100	82
Mountain	100.5	107	308.1	461.9			408.6	568.1
Percent Change	100	6	100	150			100	39
Pacific	44.5	84	231.7	316.8			276.2	400.8
Percent Change	100	88	100	137			100	45
U. S. Total	7,081.9	10,198	1,798.7	3,104.9	1,842.7	3,817.1	10,723.3	17,840
Percent Change	100	54	100	173	100	207	100	66

billion bushels will be exported through the national market (Table 2). For the wheat and soybean crops, production; the volume of surpluses, deficits, and exports; and the number of surplus and deficit regions for this scenario correspond to those described for the baseline estimate (Tables 3 and 4).

Because of the increase in demand and supply of corn and the location of new ethanol plants in the production regions, the model may endogenously determine new grain flow patterns, alternative transportation options, storage patterns or locations, and marketing costs. Since the demand for alcohol in selected regions and the transportation rates for transporting alcohol are not a part of this model, the model does not identify optimum alcohol plant locations. Instead, the impact of the proposed plant locations on the national grain marketing system is evaluated.

Export Reduction and Alcohol Scenario

For the export reduction and alcohol scenario, the baseline corn production estimates are used (Table 1). However, total corn surpluses decrease to 4.3 billion bushels relative to the baseline estimate because ethanol plants which process corn are being built. Some of the processed corn is acquired from the intraregional supply of grain which reduces corn surpluses within each region. Further, corn shipments into the grain deficit areas increase to 1.9 billion bushels relative to the baseline scenario. This increase occurs because ethanol plants are being built in the grain deficit areas; thus, demand for corn increases. Finally, corn exports decrease (1.4 billion bushels) to 2.2 billion bushels relative to the baseline estimate in order to satisfy the increase in demand for corn by ethanol processors (Table 2).

Because of the increase in demand for corn for alcohol and the corresponding decrease in demand for exports, the model endogenously determines new grain flow patterns, alternative transportation options, storage patterns or locations, and marketing and transportation costs. Optimum alcohol plant locations are again not determined and the production and disposition of the soybean and wheat crop are unchanged from that presented in the baseline model.

Storage Scenario

The volume of grain stored relative to the baseline scenario is hypothesized to increase due to deteriorating world economic and/or political conditions, or due to explicit national policy. Based on these assumptions, grain exports are assumed to decrease by approximately 50% relative to the baseline estimates and thus grain would be stored in the U. S. Since domestic grain disappearances are not altered, the grain surpluses and deficits for each region and for the U. S. are equal to surpluses or deficits reported for the baseline model (Tables 2, 3, 4, and 5).

For this storage scenario, corn exports decline from 3.7 billion bushels for the baseline scenario to 1.8 billion bushels, soybean exports decline from 1.8 billion to 904 million bushels, and wheat exports decline from 1.7 billion to 836 million bushels (Tables 2, 3, and 4). Total exports for all grains decline from 7.2 billion bushels for the baseline scenario to 3.6 billion for the storage scenario. Bushels of corn stored increase from 226 million (carryover to the following year) to 2 billion, soybean carryover increases from 313 million to 1.2 billion bushels, and wheat stored increases from 263 million to 1.1 billion bushels. Total bushels of stored grain increase from 802 million to 4.4 billion for the storage scenario (Table 5). Because of the hypothesized increase in the volume of stored grain, the model may endogenously determine new grain flow patterns, alternative transportation options, storage patterns or locations, and marketing and transportation costs.

RESULTS

Marketing Costs for Baseline Model and Policy Scenarios

For the baseline model, the marketing costs in 1980 dollars equal $5.6 billion for the 1989/90 grain marketing years; $3.1 billion or 55% of the total marketing cost is for marketing surplus corn, while an additional $1.6 billion or 28% of the total is for marketing surplus wheat. Approximately $921 million or 17% of the total cost is for marketing the surplus soybean crop (Tables 8, 9, 10, and 11). Since the per unit grain merchandising, storage, and trucking rates for each grain are equal, differences in aggregated marketing costs among the three grains reflect the volume of surplus grain and the differentials in the barge and railroad transportation rates. Therefore, the marketing cost for corn is greater than the comparable cost for either soybeans or wheat because of the relatively large corn surplus and the differential in rail and barge rates.

Total marketing costs for all three export scenarios exceed the marketing cost generated by the baseline model, equaling $5.7 billion for the super port scenario, $7.1 billion for the export scenario, and $7.2 billion for the Pacific Coast scenario (Table 11). Since the added marketing cost of $94 million for the super port scenario represents a modest 1.7% increase relative to the cost of the baseline scenario, the added cost is not a significant factor in the decision to build and route grain to super ports. The added costs are incurred to transship corn and soybeans among regions to satisfy final demands within the deficit regions and an increase in rail rates to ship corn and soybeans to the ports.[8] For example, surplus corn and soybeans which formerly moved to the lake ports at relatively low transportation rates now flow further distances to the Atlantic ports at higher transportation rates. The cost of marketing wheat declines for the export scenario as grain shipments from the Mid-South to the Atlantic ports increase, and shipments of grain from the North Plains area increase to the Pacific ports. In both cases, the change in transportation routes from grain origins to export destinations lowered transportation rates (Tables 8, 9, 10).

[8]A transshipment is defined as the transportation of grain from a surplus region by one mode (truck, for example) to a second region where the grain is reloaded onto a second mode (barge, for example) for shipment to a final destination.

TABLE 8.—U. S. Corn Shipments from 11 Production Regions to Deficit Regions and to Export Points, and Marketing Costs in Dollars, 1989/90.

	Policy Scenarios										
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
	Baseline Estimate	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
Activity Cost in Million Dollars	3,098	3,575	3,205	3,730	3,235	3,141	3,155	3,128	3,731	3,059	2,353
						(Million bu)					
Total Shipments from Production Regions to All Deficit Regions											
Northeast	7	160	7	7	7	7	7	31	31	30	7
Mid-Atlantic											
South Atlantic	44	13	44	71	44	44	44	82	42	33	52
Mid-South	94	13	85	24	84	95	95	132	96	78	62
Delta	15	45	15	16	15	13	13	15	8	15	15
Corn Belt	622	651	769	1,134	628	568	675	515	864	1,060	507
Lake States	48	20	82	128	67	58	46	147	67	85	24
North Plains	741	370	744	1,023	681	751	751	754	973	990	682
South Plains	3	50	3		1	5	5	3	3	1	2
Mountain											
Pacific		164									
Total	1,574	1,486	1,749	2,403	1,527	1,541	1,636	1,655	2,084	2,292	1,351
Total Shipments from Production Regions to Export Points											
Northeast											
Mid-Atlantic		82									
South Atlantic		101									
Mid-South		141	5	43							19
Delta											
Corn Belt	2,753	4,391	2,892	2,235	2,747	2,698	2 702	2 849			
Lake States	478	918	337	291	459	468	480	390	2 783	1,759	1,387
North Plains	440	1,016	438	140	466	395	395	432	538	367	326
South Plains				963					247	128	104
Mountain											
Pacific											
Total	3,671	6,649	3,672	3,672	3,672	3,561	3,577	3,671	3,568	2,254	1,836

TABLE 9.—U. S. Soybean Shipments from 11 Production Regions to Deficit Regions and to Export Points, and Marketing Costs in Dollars, 1989/90.

	Policy Scenarios										
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
	Baseline Estimate	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
Activity Cost in Million Dollars	921	1,109	1,107	1,841	946	964	983	921	921	921	678
						(Million bu)					
Total Shipments from Production Regions to All Deficit Regions											
Northeast											
Mid-Atlantic											
South Atlantic	78	80	167	34	72	34	34	78	78	78	34
Mid-South	1	4	69		1		5	1	1	1	9
Delta	73	1	6	76	74	15	6	73	73	73	65
Corn Belt	320	112	332	319	319	378	467	320	320	320	320
Lake States											
North Plains				73							
South Plains	6	1	6	4	6	6	6	6	6	6	5
Mountain											
Pacific											
Total	478	198	580	506	472	433	518	478	478	478	433
Total Shipments from Production Regions to Export Points											
Northeast											
Mid-Atlantic	133	184	199	88	126	88	88	133	133	133	84
South Atlantic	44	73		44	44	44	44	44	44	44	44
Mid-South	125	196	67	133	135	133	129	135	135	135	124
Delta	234	457	301	231	233	292	301	233	234	234	60
Corn Belt	987	1,284	1,058	1,139	995	1,029	945	966	987	987	577
Lake States	203	216	193	199	203	203	203	203	203	203	14
North Plains	73	77	73		73			73	73	73	
South Plains						19	19	19			
Mountain											
Pacific											
Total	1,809	2,487	1,891	1,834	1,809	1,801	1,729	1,806	1,809	1,809	903

TABLE 10.—U. S. Wheat Shipments from 11 Production Regions to Deficit Regions and to Export Points, and Marketing Costs in Dollars, 1989/90.

	Policy Scenarios										
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
	Baseline Estimate	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
Activity Cost in Million Dollars	1,603	2,376	1,505	1,603	1,624	1,670	1,698	1,605	1,603	1,603	1,603
	(Million bu)										
Total Shipments from Production Regions to All Deficit Regions											
Northeast											
Mid-Atlantic											
South Atlantic	4	5	3	4	4	2	4	4	4	4	4
Mid-South		1	15			2					
Delta	26	27	1	26	26	26	26	26	26	26	26
Corn Belt	34	14	16	34	52	44	56	36	34	34	23
Lake States	33	18	36	33	35	33	33	36	33	33	35
North Plains	927	1,569	798	927	776	930	930	927	927	927	253
South Plains	10	73	208	10	163	10	10	10	10	10	9
Mountain											
Pacific	30	57	30	30	30	30	30	30	30	30	30
Total	1,064	1,764	1,107	1,064	1,086	1,077	1,089	1,069	1,064	1,064	1,380
Total Shipments from Production Regions to Export Points											
Northeast											
Mid-Atlantic		11	3								
South Atlantic			1								
Mid-South	44	34	120	44	50	44	44	49	44	44	33
Delta	31	32	31	31	31	31	31	31	31	31	26
Corn Belt	204	299	222	204	200	193	161	202	204	204	125
Lake States	510	1,043	507	510	510	510	510	507	510	510	112
North Plains	106	143	236	106	255	104	104	106	106	106	49
South Plains	775	1,038	551	775	624	778	778	775	775	775	490
Mountain											
Pacific											
Total	1,670	2,600	1,671	1,670	1,670	1,660	1,628	1,670	1,670	1,670	835

TABLE 11.—U. S. Grain Shipments from 11 Production Regions to Deficit Regions and Export Points, and Marketing Costs in Dollars, 1989/90.

	Policy Scenarios										
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
	Baseline Estimate	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
Activity Cost in Million Dollars	5,622	7,060	5,717	7,174	5,805	5,775	5,836	5,654	6,255	5,583	3,988
						(Million bu)					
Total Shipments from Production Regions to All Deficit Regions											
Northeast	7	160	7	7	7	7	7	7	31	30	7
Mid-Atlantic											
South Atlantic	126	98	214	109	120	80	82	164	124	115	90
Mid-South	95	18	169	24	85	97	100	133	97	79	71
Delta	114	73	22	118	115	54	45	114	107	114	106
Corn Belt	976	777	1,117	1,487	999	990	1,198	871	1,218	1,414	850
Lake States	81	38	118	161	102	91	79	183	100	118	59
North Plains	1,668	1,939	1,542	2,023	1,457	1,681	1,681	1,681	1,900	1,917	935
South Plains	19	124	217	14	170	21	21	19	19	17	16
Mountain											
Pacific	30	221	30	30	30	30	30	30	30	30	30
Total	3,116	3,448	3,436	3,973	3,085	3,051	3,243	3,202	3,626	3,834	2,164
Total Shipments from Production Regions to Export Points											
Northeast											
Mid-Atlantic	133	277	202	88	126	88	88	133	133	133	84
South Atlantic	44	174	1	44	44	44	44	44	44	44	44
Mid-South	179	371	192	220	185	177	173	184	179	179	176
Delta	265	489	332	262	264	323	332	264	265	265	86
Corn Belt	3,944	5,974	4,172	3,578	3,942	3,920	3,808	4,017	3,974	2,950	2,089
Lake States	1,191	2,177	1,037	1,000	1,172	1,181	1,193	1,100	1,251	1,080	452
North Plains	619	1,236	747	246	794	499	499	611	426	307	133
South Plains	775	1,038	551	1,738	624	797	797	794	775	775	490
Mountain											
Pacific											
Total	7,150	11,736	7,234	7,176	7,151	7,029	6,934	7,147	7,047	5,733	3,574

The added marketing cost of $1.5 billion for the export scenario represents a 27% increase in cost relative to the baseline scenario and is incurred to ship more grain to the export points, transship grain among surplus producing regions and deficit grain regions, and to substitute one mode of transportation for a second. That is, the transshipments of grain by truck and the volume of grain shipped from surplus grain producing regions to deficit regions by a relatively high single car rate increase, while shipments by relatively low multi-car and barge rates decrease. Transferring grain onto trucks and single railroad cars increases the per unit cost and thus the total marketing cost for this scenario (Tables 8, 9, 10, and 11).

For the Pacific Coast scenario, the $7.2 billion marketing cost represents a 27% increase relative to the baseline scenario. Of all three export scenarios, the marketing cost for the Pacific Coast policy is the largest, reflecting relatively large changes in grain flow patterns, transportation rates, and transshipments among regions to satisfy total demand. Because of the increase in transshipments, the volume of grain shipped from surplus regions to deficit areas by all truck and railroad modes increases (Tables 8, 9, and 11).[9]

Total marketing costs for each of the four transportation scenarios exceed the marketing costs of the baseline model. For the 20% increase in the rail rate scenario and the 20% and 30% increases in barge rate scenarios, the cost is about $5.8 billion, while the rail abandonment scenario cost is $5.66 billion. These insignificant increases in total costs (less than a 1% increase to a 3% increase) occur because transshipments of grain are not increased significantly relative to the baseline scenario. In addition, the transportation routes from surplus producing regions to deficit regions and export points are not altered significantly. Finally, the model is able to substitute one set of transportation modes for a second without increasing costs significantly (Tables 8, 9, 10, and 11).

Total marketing cost for the increased corn production and alcohol scenario ($6.2 billion) exceeds the baseline model aggregate marketing cost. This significant 11% increase in cost is incurred to market the additional corn surpluses via alternative transportation routes and modes. In contrast, the marketing cost for the remaining alcohol scenario is less than the marketing cost for the baseline model (Table 11), equaling $5.6 billion. Since the cost to ship grain to export points in the baseline model is nearly offset by the increase in cost to ship additional grain to ethanol plants, the difference in cost between the two scenarios is less than 1%.

For the storage scenario, marketing costs are $4 billion, which is a 29% decrease in total costs relative to the baseline model. Since the assumptions underlying the storage scenario dictate that relatively large volumes of grain are stored while smaller quantities are shipped to deficit grain regions and export points, marketing costs are relatively low because the additional storage costs created by storing more grain are less than the decrease in the transportation cost incurred by deleting shipments to deficit areas and export points (Tables 8, 9, 10, and 11).

Total Grain Shipments by Mode of Transportation for the Baseline Model and Ten Policy Scenarios

For the baseline model, total shipments by mode of transportation to all destinations, including exports, equaled 10.3 billion bushels (Table 12). Since total demand for grain by firms in the deficit grain marketing regions and at export points equaled 9.0 billion bushels (Table 5), 1.3 billion bushels of grain or nearly 13% of the total grain supply is transshipped among and within marketing areas in order to meet all demands. Similar trends are also displayed for each grain in Tables 8, 9, 10, 13, 14, and 15.

In contrast to the result for the baseline model, policies which stimulate exports (the export scenario), create super ports (the super port scenario), or cause exports to flow to the West Coast relative to the East Coast (the Pacific Coast scenario) significantly increase the volume of grain and the percentage of surplus grain transshipped among the grain surplus and deficit areas (Table 11 and Figure 4). For example, the export scenario increases transshipments to 2.9 billion bushels or 22% of the total grain surpluses. Most of the increase in transshipments is a result of the increase in wheat shipments by single railroad car from the North Plains region to the Lake States areas where the wheat is loaded onto barges for shipment to the Gulf. Alternative train load rates are not available for moving wheat to the Gulf, the introduction of which could change this outcome by 1990. In contrast, corn and soybean transshipments into grain deficit regions decline for this scenario because the additional soybean and corn exports are transported by existing train load rates. The Pacific Coast scenario also increases transshipments to 2.3 billion bushels, 23% of total grain surpluses. Additional corn and soybeans are transshipped out of the Corn Belt, North Plains, or South Atlantic regions as new grain flow patterns and demands are introduced by this scenario. Finally, the super port scenario also increases transshipments to 1.7 billion bushels or 17% of the total grain surpluses. This occurs for all three grains and reflects the loading of grain onto railroad cars and trucks for shipment to rivers where the grain is loaded onto barges for shipments to the newly constructed super ports (Tables 8, 9, and 11).

Policies which stimulate rail companies to abandon rail lines (rail abandonment scenario) and transfer prior corn exports to domestic alcohol processing plants (export and alcohol scenario) do not significantly increase transshipments relative to those of the baseline model and do not significantly increase total grain shipments (Tables 12, 13, 14, and 15). Policies which permit rail rates to increase by 20% (20% increase in rail rate scenario), barge rates to increase 20% and 30%, respectively (increase in barge rate scenarios), increase

[9]Multi-car and train load rates from Plains areas to the West Coast were not provided by TVA. The introduction of those rates into this model would reduce the cost.

TABLE 12.—U. S. Grain Shipments by Mode of Transportation to Deficit Regions and Export Points, 1989/90.

Transportation Modes	Policy Scenarios										
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
	Baseline Estimate	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
	(Million bu)										
Total Shipments to Deficit Regions											
Truck	64	217	238	169	242	64	64	64	73	79	183
Barge	73	56	174	41	59	30	27	139	209	184	40
Rail	2,979	3,175	3,024	3,763	2,784	2,957	3,152	2,999	3,344	3,571	1,941
Single Car	2,175	2,457	1,889	2,723	2,110	2,128	2,217	2,171	2,494	2,725	1,290
Multi Car	782	713	1,100	1,018	652	806	833	806	828	824	629
Train Load	22	5	35	22	22	23	102	22	22	22	22
Total	3,116	3,448	3,436	3,973	3,085	3,051	3,243	3,202	3,626	3,834	2,164
Total Shipments to Export Points											
Truck	701	1,124	573	1,610	404	694	694	959	674	672	302
Barge	2,408	3,959	2,573	1,538	2,651	1,789	1,779	2,386	2,278	1,976	1,579
Rail	4,041	6,653	4,088	4,028	4,096	4,546	4,461	3,802	4,095	3,085	1,693
Single Car	1,245	2,371	752	1,892	1,459	1,443	1,447	956	1,289	1,145	744
Multi Car	697	818	772	553	581	815	804	782	653	424	245
Train Load	2,099	3,464	2,564	1,583	2,056	2,288	2,210	2,065	2,153	1,516	704
Total	7,150	11,736	7,234	7,176	7,151	7,029	6,934	7,147	7,047	5,733	3,574
Total Shipments to Deficit Regions and Export Points											
Truck	765	1,341	811	1,779	646	758	758	1,023	747	751	485
Barge	2,481	4,015	2,747	1,579	2,710	1,819	1,806	2,525	2,487	2,160	1,619
Rail	7,020	9,828	7,112	7,791	6,880	7,503	7,613	6,801	7,439	6,656	3,634
Single Car	3,420	4,828	2,641	4,615	3,569	3,571	3,664	3,127	3,783	3,870	2,034
Multi Car	1,479	1,531	1,872	1,571	1,233	1,621	1,637	1,588	1,481	1,248	874
Train Load	2,121	3,469	2,599	1,605	1,078	2,311	2,312	2,086	2,175	1,538	726
Total	10,266	15,184	10,670	11,149	10,236	10,080	10,177	10,349	10,673	9,567	5,738

TABLE 13.—U. S. Corn Shipments by Mode of Transportation to Deficit Regions and Export Points, 1989/90.

Transportation Modes	Policy Scenarios										
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
	Baseline Estimate	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
	(Million bu)										
Total Shipments to Deficit Regions											
Truck	20	110	20	26	30	20	20	20	29	35	17
Barge	61	44	61	30	45	21	17	124	197	172	29
Rail	1,493	1,332	1,668	2,347	1,452	1,500	1,599	1,511	1,858	2,085	1,305
Single Car	893	727	893	1,466	970	890	988	892	1,212	1,443	812
Multi Car	600	605	775	881	482	610	611	619	646	642	493
Train Load											
Total	1,574	1,486	1,749	2,403	1,527	1,541	1,636	1,655	2,084	2,292	1,351
Total Shipments to Export Points											
Truck	29	145		992	29	29	29	280	2		
Barge	763	1,647	882	145	849	436	434	738	633	331	700
Rail	2,879	4,857	2,790	2,535	2,794	3,096	3,114	2,653	2,933	1,923	1,136
Single Car	858	1,102	193	510	464	434	450	107	402	258	208
Multi Car	600	643	567	503	472	722	722	636	556	327	245
Train Load	1,921	3,112	2,030	1,522	1,858	1,940	1,942	1,910	1,975	1,338	1,683
Total	3,671	6,649	3,672	3,672	3,672	3,561	3,577	3,671	3,568	2,254	1,836
Total Shipments to Deficit Regions and Export Points											
Truck	49	255	20	1,018	59	49	49	300	31	35	17
Barge	824	1,691	943	175	894	457	451	862	830	503	729
Rail	4,372	6,189	4,458	4,882	4,246	4,596	4,713	4,164	4,791	4,008	2,441
Single Car	1,251	1,829	1,086	1,976	1,435	1,324	1,438	999	1,614	1,701	1,020
Multi Car	1,200	1,248	1,342	1,384	954	1,332	1,333	1,255	1,202	969	738
Train Load	1,921	3,112	2,030	1,522	1,858	1,940	1,932	1,910	1 975	1,338	683
Total	5,245	8,135	5,421	6,075	5,199	5,102	5,213	5,326	5,652	4,546	3,187

TABLE 14.—U. S. Soybean Shipments by Mode of Transportation to Deficit Regions and Export Points, 1989/90.

Transportation Modes	Policy Scenarios										
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
	Baseline Estimate	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
Total Shipments to Deficit Regions	(Million bu)										
Truck	11	1	11	110	11	11	11	11	11	11	133
Barge	1	1	1		1			4	1	1	
Rail	466	196	568	396	460	422	507	463	466	466	300
Single Car	338	102	271	313	339	280	271	335	338	338	207
Multi Car	128	94	284	83	121	142	156	128	128	128	93
Train Load			13				80				
Total	478	198	580	506	472	433	518	478	478	478	433
Total Shipments to Export Points											
Truck	79	52	22	25	67	72	72	79	79	79	2
Barge	894	943	936	642	894	717	709	891	894	894	593
Rail	836	1,492	933	1,167	848	1,019	948	836	836	836	308
Single Car	613	1,035	459	1,108	592	638	647	631	613	613	287
Multi Car	53	121	135	6	60	54	54	53	53	53	
Train Load	170	336	339	53	196	327	247	152	170	170	28
Total	1,809	2,487	1,891	1,834	1,809	1,808	1,729	1,806	1,809	1,809	903
Total Shipments to Deficit Regions and Export Ponts											
Truck	90	53	33	135	78	83	83	90	90	90	135
Barge	895	944	937	642	895	717	709	895	895	895	593
Rail	1,302	1,688	1,501	1,563	1,308	1,441	1,455	1,299	1,302	1,302	608
Single Car	951	1,137	730	1,421	931	918	918	966	951	951	494
Multi Car	181	215	419	89	181	196	210	181	181	181	93
Train Load	170	336	352	53	196	327	327	152	170	170	21
Total	2,287	2,685	2,471	2,340	2,281	2,241	2,247	2,284	2,287	2,287	1,336

TABLE 15.—U. S. Wheat Shipments by Mode of Transportation to Deficit Regions and Export Points, 1989/90.

Transportation Modes	Policy Scenarios										
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
	Baseline Estimate	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
Total Shipments to Deficit Regions	(Million bu)										
Truck	33	106	207	33	201	33	33	33	33	33	33
Barge	11	11	112	11	13	9	10	11	11	11	11
Rail	1,020	1,647	788	1,020	872	1,035	1,046	1,025	1,020	1,020	336
Single Car	944	1,628	725	944	801	958	958	944	944	944	271
Multi Car	54	14	41	54	49	54	66	59	54	54	43
Train Load	22	5	22	22	22	23	22	22	22	22	22
Total	1,064	1,764	1,107	1,064	1,086	1,077	1,089	1,069	1,064	1,064	380
Total Shipments to Export Points											
Truck	593	927	551	593	308	593	593	600	593	593	300
Barge	751	1,369	755	751	908	636	636	757	751	751	286
Rail	326	304	365	326	454	431	399	313	326	326	249
Single Car	274	234	100	274	403	371	350	218	274	274	249
Multi Car	44	54	70	44	49	39	28	93	44	44	
Train Load	8	16	195	8	2	21	21	2	8	8	
Total	1,670	2,600	1,671	1,670	1,670	1,660	1,628	1,670	1,670	1,670	835
Total Shipments to Deficit Regions and Export Points											
Truck	626	1,033	758	626	509	626	626	633	626	626	333
Barge	762	1,380	867	762	921	645	646	768	762	762	297
Rail	1,346	1,951	1,153	1,346	1,326	1,466	1,445	1,338	1,346	1,346	585
Single Car	1,218	1,862	825	1,218	1,204	1,329	1,308	1,162	1,218	1,218	520
Multi Car	98	68	111	98	98	93	94	152	98	98	43
Train Load	30	28	217	30	24	44	43	24	30	30	22
Total	2,734	4,364	2,778	2,734	2,756	2,737	2,717	2,739	2,734	2,734	1,215

corn production in order to manufacture alcohol (production and alcohol scenario), and allocate more grain for storage (storage scenario) decrease the volume of grain transshipped among the grain surplus and deficit regions. Transshipments decrease because the increases in transportation rates negate the need for multiple shipments by different transportation modes. This is grain which is loaded directly onto cars and or barges for shipment to deficit areas, avoiding additional handling and transportation activities. The decrease in transshipments for the production and alcohol scenario is insignificant and is somewhat surprising as more total corn surpluses exist. Not surprising is the decrease in transshipments for the storage scenario, as most grain is stored within the area in which it is produced. Thus, wheat is no longer shipped by rail into the Lake States for barging to the ports. Since demand for all transportation services declines for these latter five policy scenarios, transportation and marketing costs are decreased (Tables 12, 13, 14, and 15).

For the baseline model, 765 million bushels or 7% of all shipments move by truck, 2.5 billion bushels or 24%

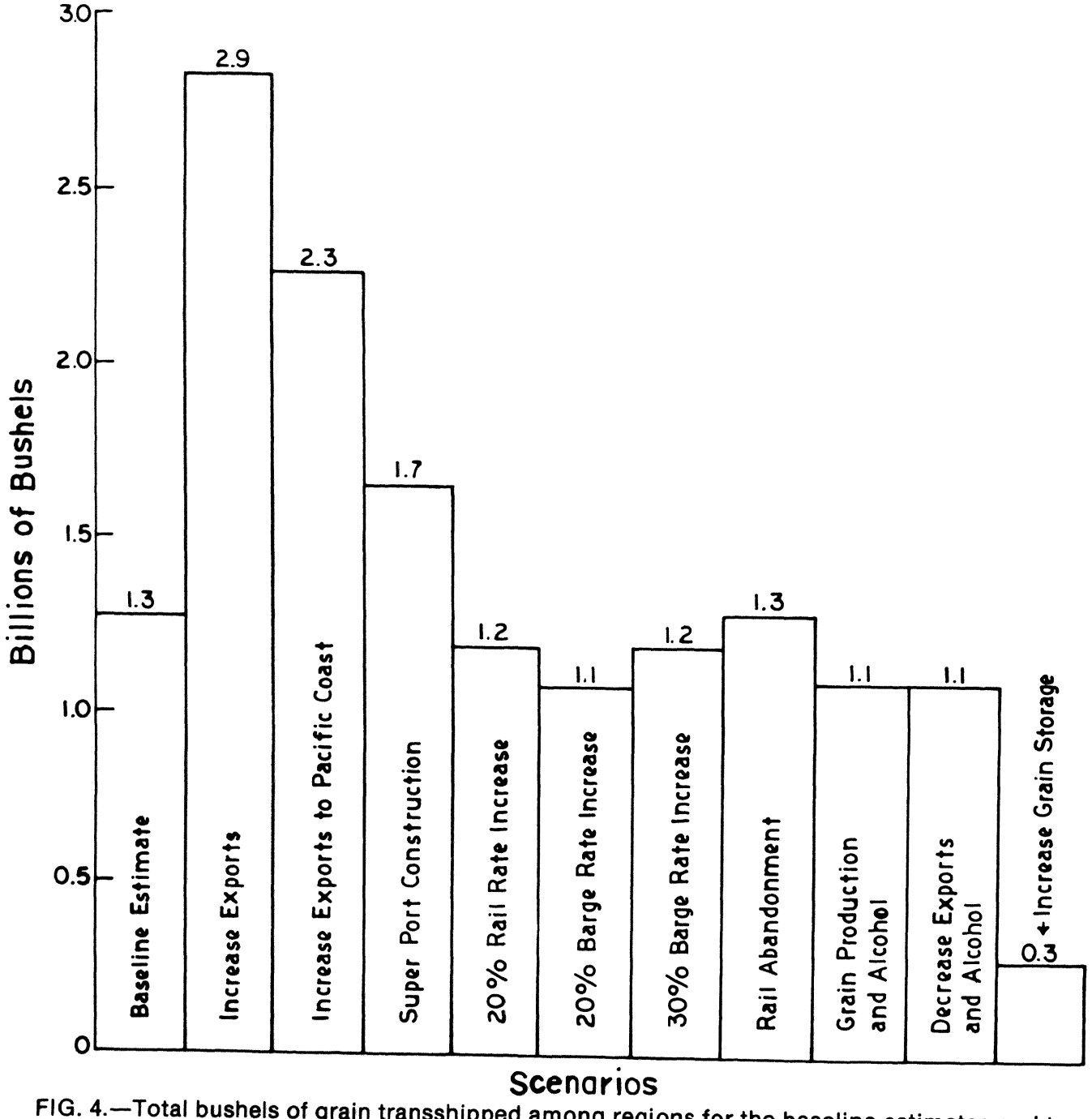

FIG. 4.—Total bushels of grain transshipped among regions for the baseline estimates and ten policy scenarios.

of the total move by barge, and 7.0 billion bushels or 69% of the total move on the railroads; 49% of all railroad shipments are hauled by single car rates, 30% by train load, and 11% by multi-car rates (Tables 12 and 16). The export scenario increases truck and barge shipments relative to rail shipments and substitutes train load shipments for multi-car shipments. The super port scenario also increases truck and barge traffic relative to rail movements, but single car shipments decrease while multi-car and train load grain shipments increase. For the Pacific Coast scenario, grain transported on trucks increases significantly, barge traffic declines significantly, and rail movements of grain increase modestly. The volume of grain moved on single car rates increases significantly, grain movements via train load rates decrease significantly, while shipments by multi-car rates decrease by only 1% relative to the baseline model. The 20% increase in the rail rate scenario modestly increases barge shipments of grain relative to rail and truck shipments. In addition, more grain is shipped by single car rates and less is shipped by multi-car rates. As barge rates increase, grain shipments by rail increase and barge traffic declines. The rail abandonment scenario increases truck traffic and decreases rail traffic. Since single car rates are eliminated in the Corn Belt, more grain is transported via multi-car rates. The alcohol scenarios do not alter the distribution of grain shipments among the three modes of transportation significantly; however, a higher percentage of grain is transported on single car rates and less is transported on multi-car and train load rates. Finally, the storage scenario increases barge and truck shipments relative to rail shipments and increases the percentage of grain transported on single and multi-car rates relative to the train load rates (Tables 12, 13, 14, 15, and 16). The reasons for these changes in the importance of the transportation modes are examined in the next sections on grain shipments to deficit regions and grain shipments to export points.

Grain Shipments to Deficit Regions by Mode of Transportation for the Baseline Model and Ten Policy Scenarios

For the baseline model, total shipments of grain into the deficit regions including transshipments equal 3.1 billion bushels for the baseline estimate. Of this total, 1.6 billion bushels of corn are shipped from surplus regions to the deficit areas, 478 million bushels of soybeans and 1.1 billion bushels of wheat move between the surplus regions and the grain deficit areas (Tables 8, 9, 10, and 11). Since a large supply of corn is produced in the U. S. and large quantities are processed into feed in the consumption areas, more than 50% of all domestic grain shipments are corn movements (Tables 8 and 11). Smaller quantities of wheat and soybeans are shipped among the areas because smaller quantities of these crops are produced, and relatively large quantities of soybeans and wheat are processed into meals, oils, or flour in the production areas and are shipped as a milled product, rather than being shipped as a raw grain.

TABLE 16.—U. S. Grain Shipments by Mode of Transportation to All Destinations, Percentages, 1989/90.

	Policy Scenarios											
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios			
Transportation Modes	Baseline Estimate	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
All Shipments	100	100	100	100	100	100	100	100	100	100	100
Truck	7	9	8	16	6	8	7	10	7	8	8
Barge	24	26	26	14	26	18	18	24	23	23	23
Railroad	69	65	66	70	68	74	75	66	70	69	64
All Railroad Shipments	100	100	100	100	100	100	100	100	100	100	100
Single Car	49	49	37	59	52	48	48	46	51	58	56
Multi Car	21	16	26	20	18	22	22	23	20	19	24
Train Load	30	35	37	21	30	30	30	31	29	23	20

TABLE 17.—U. S. Grain Shipments by Mode of Transportation from Surplus Grain Producing Regions to Grain Deficit Regions, Percentages, 1989/90.

		Policy Scenarios									
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
Transportation Modes	Baseline Estimate	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
All Shipments	100	100	100	100	100	100	100	100	100	100	100
Truck	2	6	7	4	8	2	2	2	2	2	8
Barge	2	2	5	1	2	1	1	4	6	4	2
Railroad	96	92	88	95	90	97	97	94	92	93	90
All Railroad Shipments	100	100	100	100	100	100	100	100	100	100	100
Single Car	73	77	62	72	76	72	70	72	74	76	66
Multi Car	26	22	36	27	23	27	27	27	23	23	32
Train Load	1	1	2	1	1	1	3	1	1	1	1

Grain shipments into the deficit areas increase for the export scenario and for the super port, Pacific Coast, rail abandonment, 30% increase in barge rates, corn production increase and alcohol, and the export reduction and alcohol scenarios. The differences in the volume of shipments into grain deficit areas are attributed to the additional transshipments of grain to meet changing export demands, or the additional flow of grain into the deficit areas to satisfy the additional demand for corn by alcohol processing plants. In contrast, shipments into the deficit regions decline when the storage and 20% rail and barge rate scenarios are introduced. For these latter three scenarios, transshipments among domestic grain surplus and deficit regions decline.

For the baseline estimate, 3.1 billion bushels or 96% of the total grain shipments moved by railroad cars (Tables 12 and 17). Only 64 million bushels and 73 million bushels of grain (2% of all shipments) are shipped by truck and barge, respectively, from the surplus grain regions to the deficit grain areas. Rail is the predominant mode of transportation because of favorable rail rates and transportation routes. That is, rail rates into the deficit areas are less than the corresponding truck rates and most demand centers are located on rail lines rather than on barge or river sites. The single rail car is the predominant mode of transportation, while large quantities also move via multi-car rates. Only small quantities (less than 1%), moved via train load rates (Table 17). The latter rate option is not used because these rates are often not available to move grain from the surplus regions to deficit areas, and/or firms in the deficit areas have inadequate storage or receiving capacity to unload grain from trains. Changes in the rate structure and/or the receiving and storage capacities of the firms located in the deficit grain areas could alter this result by 1990.

Most corn shipments into the deficit regions are also moving via rail; 893 million bushels are shipped by single car rates, 600 million are shipped by multi-car rates, 61 million bushels move by barge, and 20 million bushels are shipped via trucks. Train load rates are not used to move corn into the deficit areas (Table 13). Soybeans are also primarily transported by rail, with 338 million bushels moving by single car rates, 128 million bushels via multi-car rates, 11 million by truck, and 1 million by barge (Table 14). Wheat shipments by rail equal 1 billion bushels, of which 944 million moved by single car rates, 54 million moved by multi-car, and 22 million bushels moved by train load rates. Only 33 million bushels are transported by truck and 11 million by barge (Table 15).

With the exception of the export, super port, 20% increase in rail rates, and the storage scenarios, the percentage of grain shipments transported by mode of transportation to the grain deficit areas for most policies nearly equals the shipments for the baseline model (Tables 12 and 16). For all four scenarios, the volume of grain transported via truck and/or barge increases while the volume hauled on the railroad system decreases. Truck traffic becomes more important for the

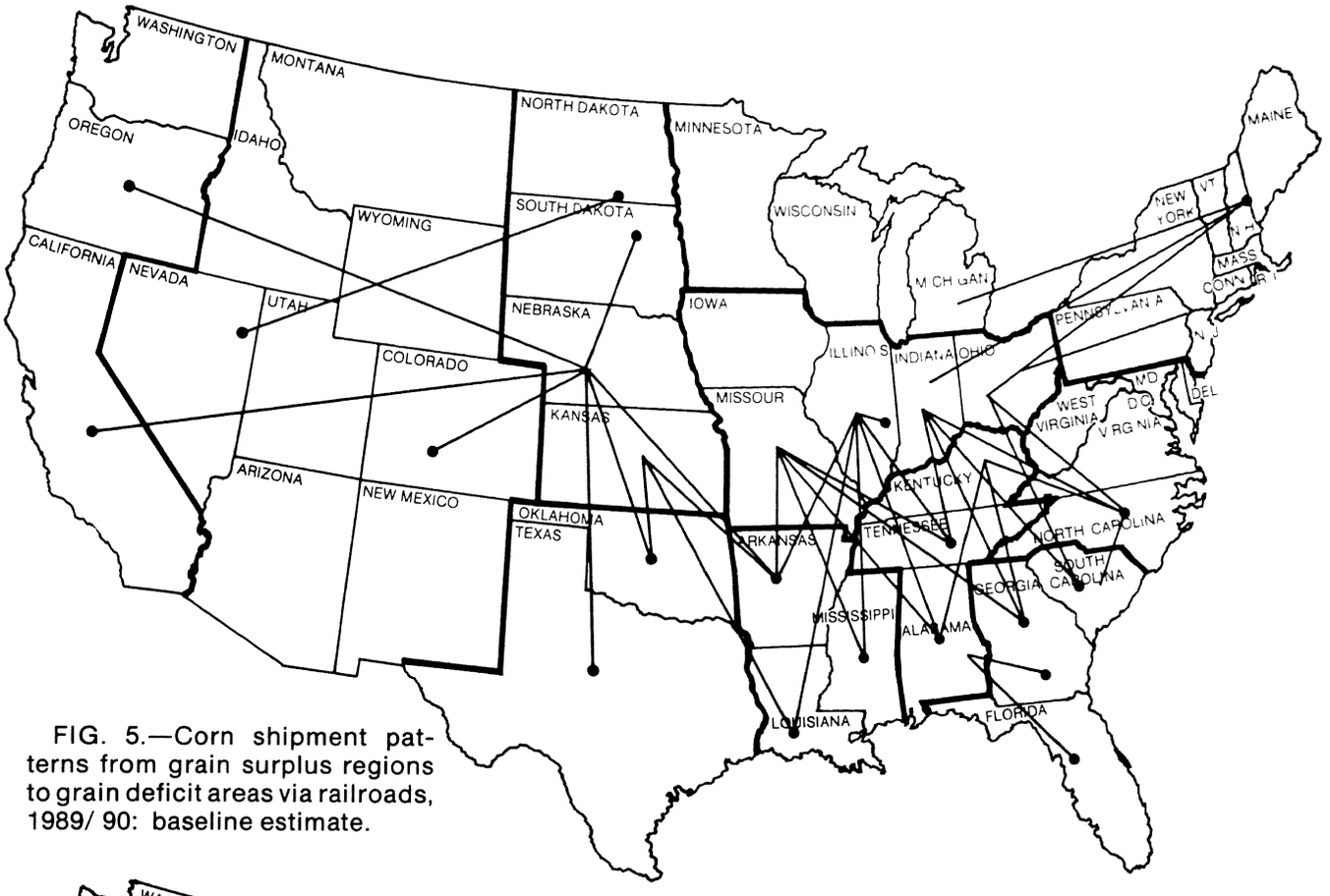

FIG. 5.—Corn shipment patterns from grain surplus regions to grain deficit areas via railroads, 1989/ 90: baseline estimate.

FIG. 6.—Corn shipment patterns from grain surplus regions to grain deficit areas via barges, 1989/90: baseline estimate.

export and super port scenarios because of the increase in transshipments of grain among the domestic regions to meet the changing demand for grain exports. In addition, the construction of super ports permits more grain to be moved down the river to the Gulf ports. Not surprising, the 20% increase in rail rates transfers grain from the railroad to truck traffic. Since most consumption centers are not located on rivers, grain cannot be transferred from the railroad system to barge lines to satisfy domestic demands. Finally, the increase in the volume of grain stored increases truck traffic relative to rail traffic because single railroad car transshipments from the North Plains to the Lake States are eliminated. That is, the increase in storage and the corresponding decrease in exports eliminate the need to transship grain from the North Plains area via the Lake States to the ports.

For the baseline estimate, firms located in the North Plains and Corn Belt regions ship large quantities of grain into the deficit regions, with much smaller quantities originating in the South Atlantic, Mid-South, Delta, Lake States, South Plains, and Pacific areas. Corn shipments to the Northeast, Mid-Atlantic, Mid-South, South Atlantic, and South Plains grain deficit regions originate from the Corn Belt (Table 8 and Figures 5 and 6). In addition, grain elevators located in the South and the North Plains surplus grain producing regions ship corn into the South. Finally, the North Plains region also ships corn into the Pacific and Mountain grain deficit regions. Most corn shipments into the South and Northeast are transported by rail, while all shipments into the West move by rail. A small quantity of corn moves down the Mississippi and Tennessee rivers to grain deficit areas in the South.

Most of the policy scenarios did not have a significant impact on the directional flow of corn. Noted exceptions include the rail abandonment scenario, as more corn is shipped by barge and truck into the South relative to the baseline scenario (Fig. 7). Further, the 30% increase in barge rate scenario increases the flow of corn from the South Plains surplus region by rail and diminishes the flow of corn by barge traffic down the rivers to the Southern grain deficit areas. Finally, the two alcohol scenarios significantly influence corn flow patterns from surplus corn producing areas to deficit regions. For example, large quantities of corn are shipped by rail into the South, Northeast, and West and large quantities of corn are shipped by barge into the South (Figures 8 and 9).

For the baseline estimate, soybean shipments into grain deficit areas and the number of shipment patterns are inconsequential relative to corn and wheat ship-

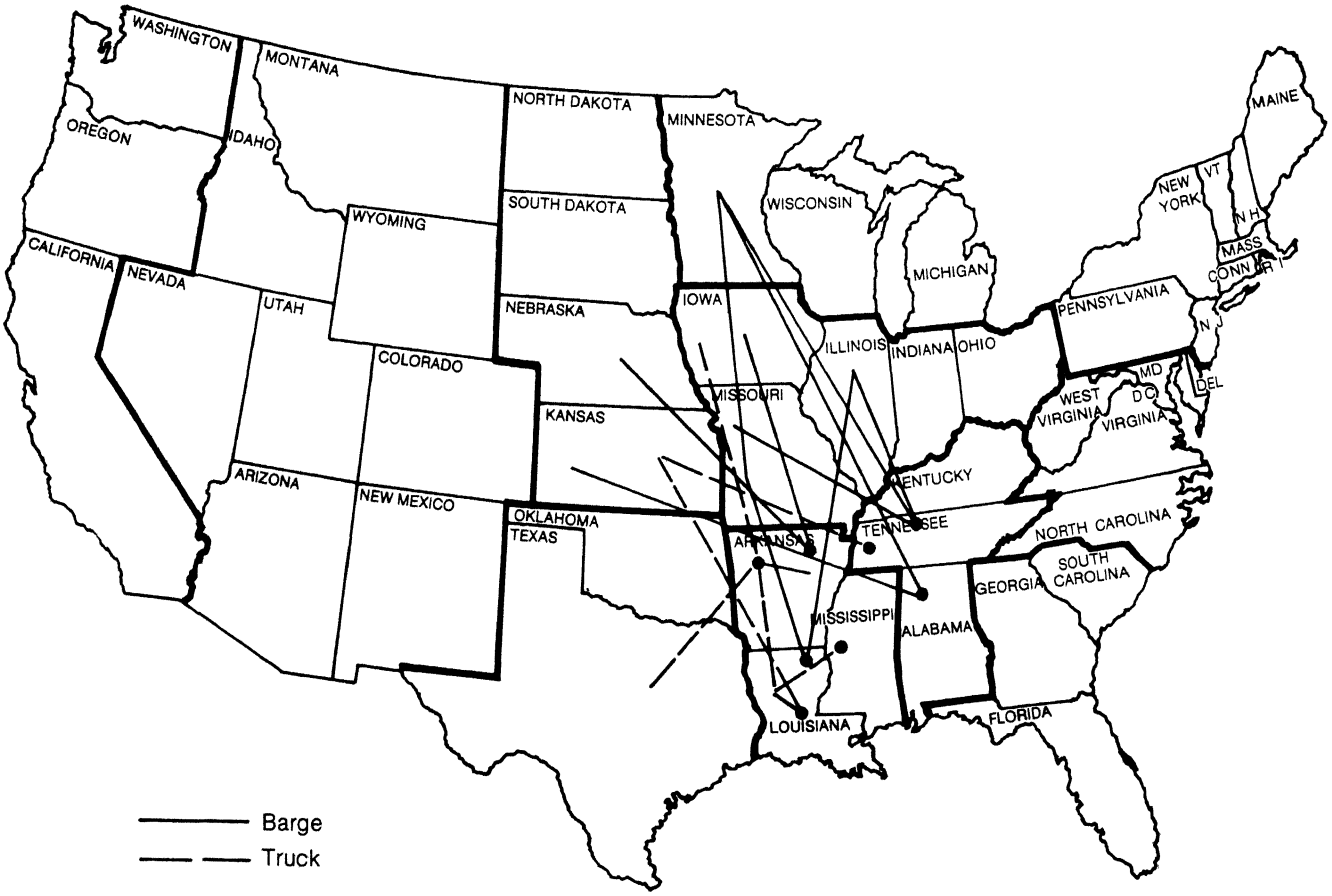

FIG. 7.—Corn shipment patterns from grain surplus regions to deficit areas via barge and truck transportation modes, 1989/90: rail abandonment scenario.

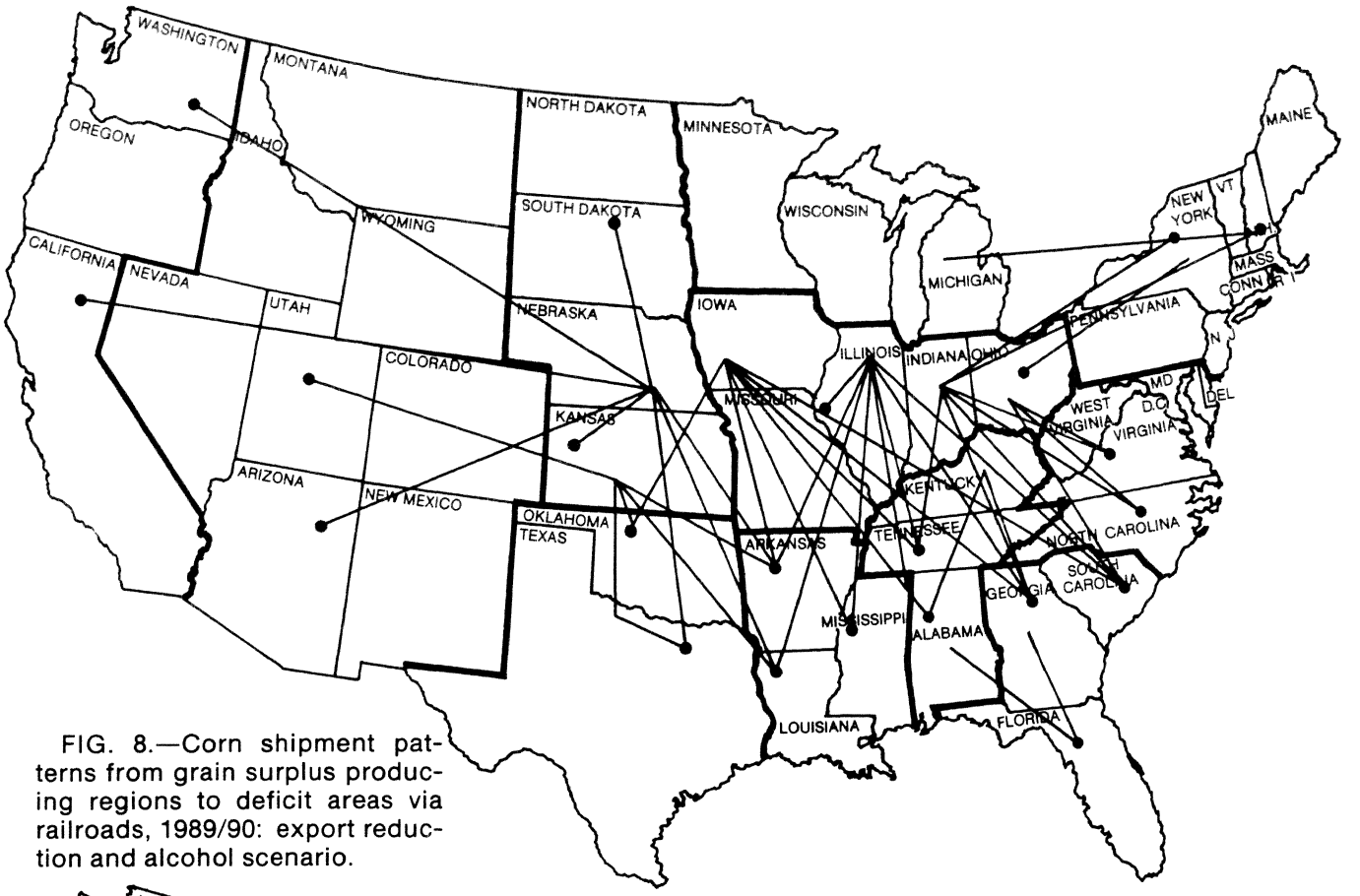

FIG. 8.—Corn shipment patterns from grain surplus producing regions to deficit areas via railroads, 1989/90: export reduction and alcohol scenario.

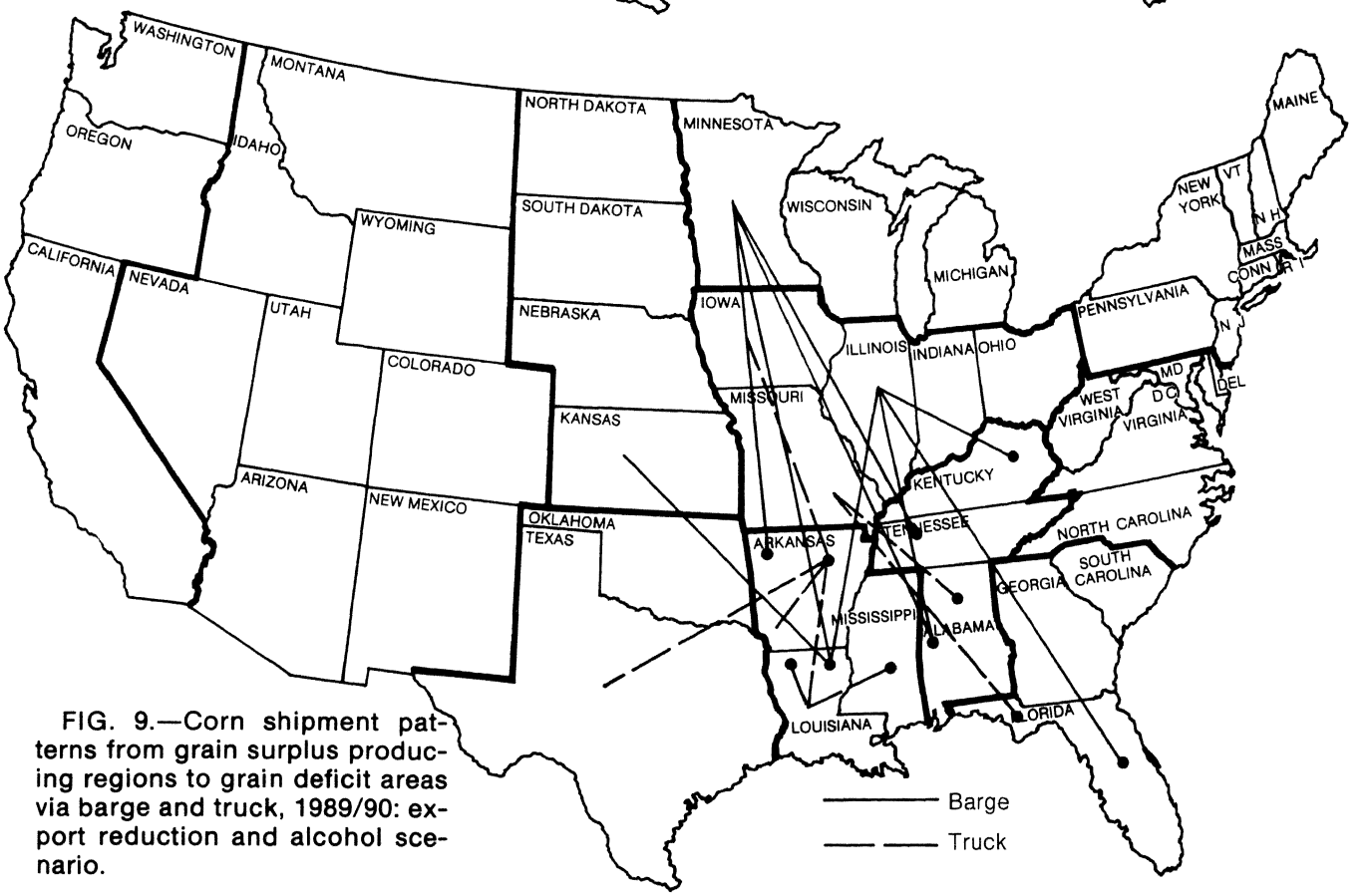

FIG. 9.—Corn shipment patterns from grain surplus producing regions to grain deficit areas via barge and truck, 1989/90: export reduction and alcohol scenario.

ments (Table 9 and Figure 10). Since most soybeans are processed in the region in which they are produced or flow to export points, only small quantities flow among regions in the Corn Belt and to processors located in the South. Nearly all shipments are by rail.

Because the volume of shipments and the number of shipment patterns for soybeans are small, the alternative policies had little effect on the soybean flow patterns. However, the rail abandonment scenario increases barge movements on the Ohio River in order to satisfy soybean processing demands in the South, and the 30% increase in barge rates causes more soybeans to move from the Corn Belt by railroad and less by barge.

For the baseline estimate, wheat shipments to the South and Northeast also originate in the Corn Belt, the Lake states, and the South Plains production areas (Table 10 and Figures 11 and 12). Because wheat processors in the Corn Belt require different varieties of wheat for processing flour, wheat originating in the Plains area also flows into the Corn Belt. Finally, small quantities of wheat are shipped West from the South Plains and North Plains production regions. All shipments into the Northeast and West move on the railroad. Most wheat shipments into the South and Corn Belt also move on the railroad, but smaller quantities also move by barge into the South via the Mississippi and Tennessee rivers and into the Corn Belt via the Mississippi and Illinois rivers. Specifically, wheat is barged from the Lake States to Illinois, Missouri, and Iowa; barged from Kansas into Missouri, Illinois, and Tennessee; and barged from Nebraska to Alabama. These flow patterns are not significantly altered when the policy scenarios are intruded. The one exception is the 20% increase in rail rates which causes more wheat to flow from the Plains surplus grain area into the Northeast.

Grain Shipments to Export Points by Mode of Transportation for Baseline Model and Ten Policy Scenarios

For the baseline model, 7.2 billion bushels of grain are shipped to eight export points (Tables 11 and 12). Of this total, 3.7 billion bushels of corn (51% of all grain exports) are shipped from surplus regions to export points; 1.8 billion bushels of soybeans (25% of all grain exports) and 1.7 billion bushels of wheat (24% of all exports) also flow to export (Tables 13, 14, and 15). Shipments of corn exceed the combined shipments of wheat and soybeans because there is a relatively large supply of corn, and some wheat and soybeans are processed into flour, meal, and oil for export.

Total shipments of grain to all export points are exogenously determined within the model. Thus, all

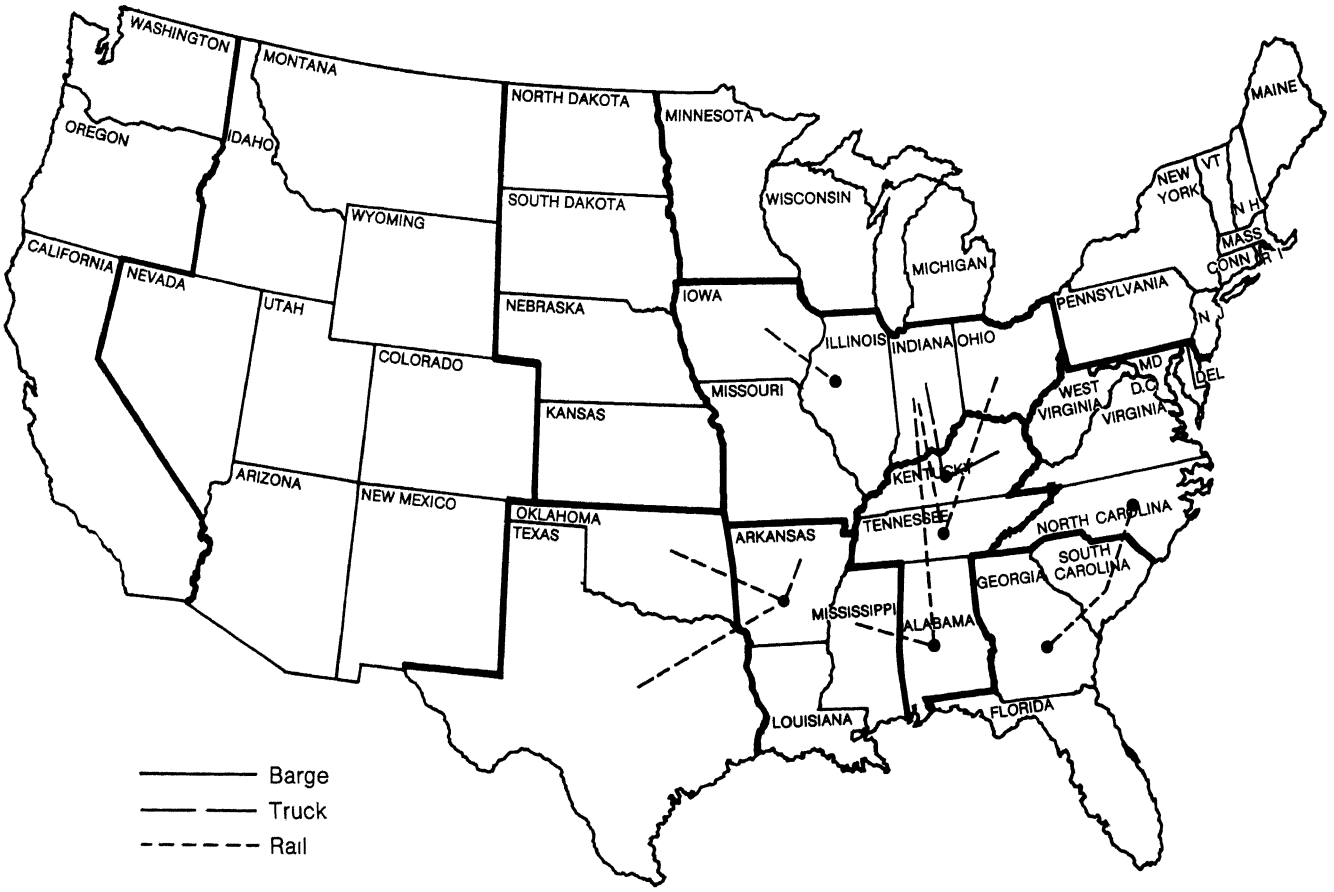

FIG. 10.—Soybean shipment patterns from grain surplus producing regions to deficit areas for three transportation modes, 1989/90: baseline estimate.

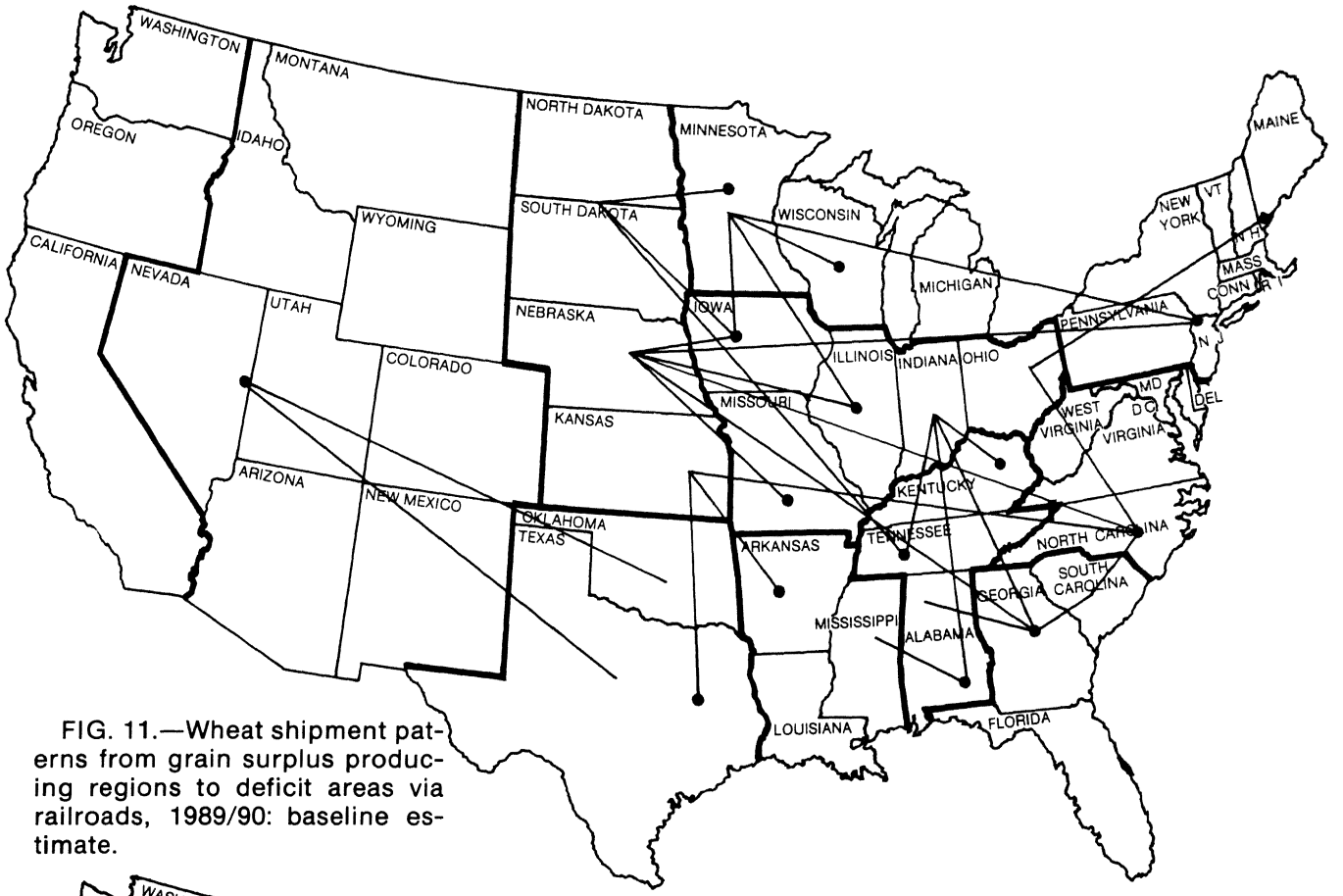

FIG. 11.—Wheat shipment patterns from grain surplus producing regions to deficit areas via railroads, 1989/90: baseline estimate.

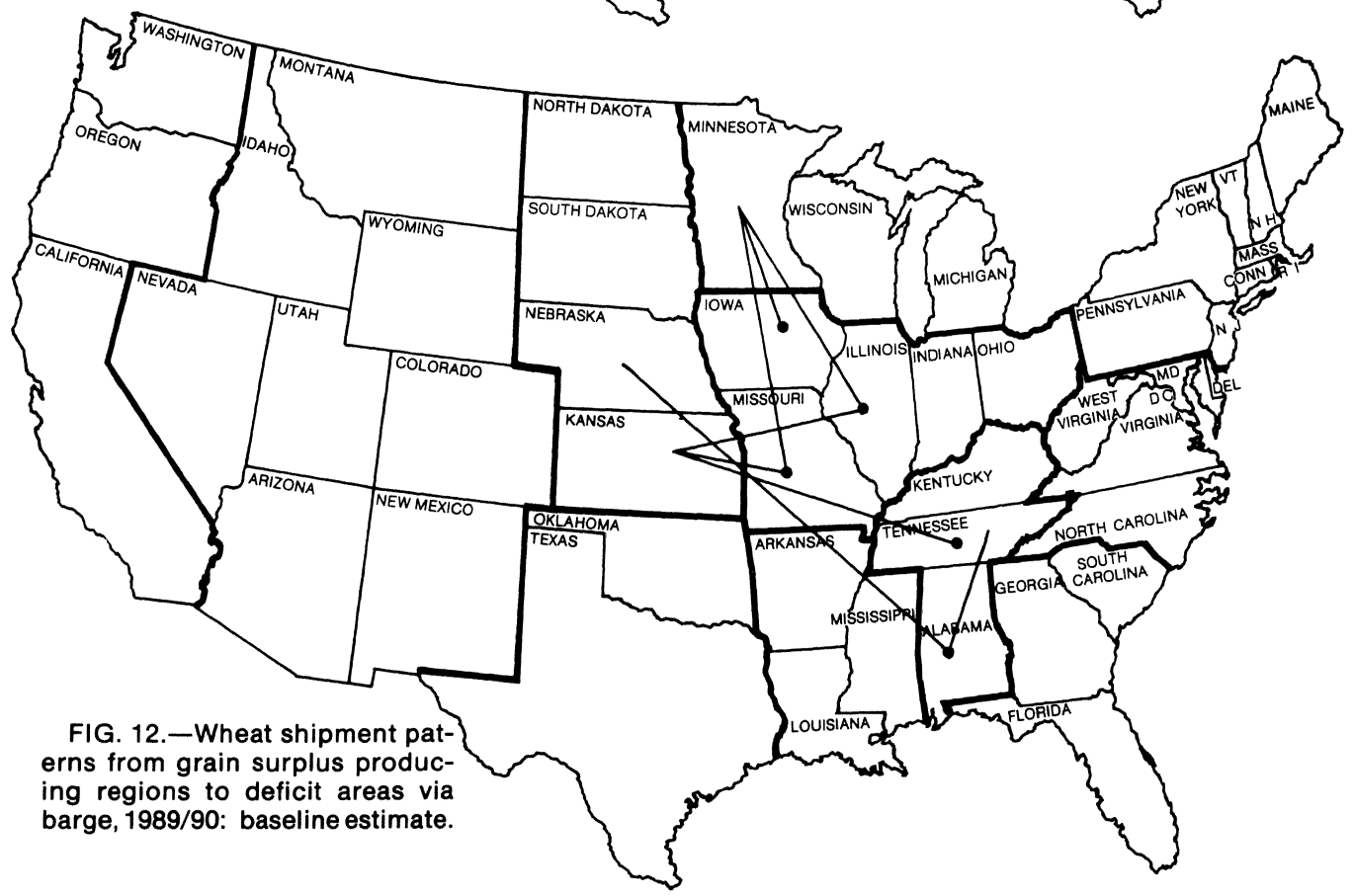

FIG. 12.—Wheat shipment patterns from grain surplus producing regions to deficit areas via barge, 1989/90: baseline estimate.

TABLE 18.—U. S. Grain Shipments by Mode of Transportation from Surplus Grain Producing Regions to Export Points, Percentages, 1989/90.

		Policy Scenarios									
		Export Scenarios			Transportation Scenarios				Alcohol Scenarios		
Transportation Modes	Baseline Estimate	Increase Exports	Super Port Construction	Increase Exports to Pacific Coast	20% Rail Rate Increase	20% Barge Rate Increase	30% Barge Rate Increase	Rail Abandonment	Grain Production and Alcohol	Decrease Exports and Alcohol	Increase Grain Storage
All Shipments	100	100	100	100	100	100	100	100	100	100	100
Truck	10	10	8	22	7	10	10	13	10	12	8
Barge	34	34	36	22	37	25	25	34	32	34	44
Railroad	56	56	56	56	56	65	65	53	58	54	48
All Railroad Shipments	100	100	100	100	100	100	100	100	100	100	100
Single Car	31	36	18	46	36	31	32	25	31	37	44
Multi Car	17	12	19	14	14	17	18	21	16	14	14
Train Load	52	52	63	40	50	52	50	54	52	49	42

differences in the volume of grain shipments to export points are due to rounding errors or to the specific policy scenario assumptions. The latter causes shipments to increase for the export scenario and causes a decrease in total shipments for the export reduction and alcohol and storage scenarios.

For the baseline estimate, nearly 56% of all grain exports, or 4 billion bushels of grain, move on the railroad. An additional 2.4 billion bushels (34% of all shipments) are transported via barge and 701 million bushels (10% of the total) are transported by trucks (Tables 12 and 18). When contrasted to the transportation data for domestic shipments, rail movements of grain are less important in the export market and barge and truck movements are more important. In addition, single railroad car traffic is less important for the export shipments relative to domestic shipments; 1.2 billion bushels or 31% of all rail exports move on the single car rate. Train loads of grain are the most significant, moving 2.1 billion bushels or 52% of all rail shipments. The least important rail rate is the multi-car rate, where only 697 million bushels are hauled, equaling 17% of all exports (Tables 12 and 18).

More grain moves to export via barge routes and train load rates relative to domestic shipments because most export points are on rivers and train load rates to export points are quoted. As pointed out in the domestic shipment section of this paper, neither of these are significant factors for domestic shipments. Truck traffic is somewhat important in the export market because of transshipments where grain is loaded on trucks and then onto barges, and because some grain is transported short distances from interior origins in the Corn Belt to Lake ports and from interior points in the South to ports located on the Atlantic and Gulf Coasts. The diversity of shipments between the domestic demand points and the export sites is consistent with those findings from prior surveys (5, 9. 10).

With the exception of the export scenario, most policies impact the percentage of grain moved by transportation mode. Although there was an increase in demand for transportation services for the export scenario, the percentage of grain moved by transportation mode did not change relative to the base model (Tables 12 and 18). However, an examination of railroad shipments indicates that the percentage of single car shipments increases to 36%, that multi-car shipments decrease to 12% of the total, and that train load shipments remain unchanged at 52% of the total relative to the baseline model (Table 18). In contrast to the export scenario, the super port and Pacific Coast scenarios did not increase the demand for transportation services; however, each scenario modifies the percentage of grain moved by transportation mode. For the super port scenario, rail shipments remain unchanged while truck shipments decline to 8% of all shipments and barge shipments increase to 36% of all shipments. In addition, rail shipments by single car rates decline to 18% of all rail shipments, multi-car shipments of grain increase modestly to 19%, and train load shipments increase significantly to 63% of all rail shipments (Tables 12 and 18). Since all

super ports are located on barge lines and rail sites which have train load rates, the model minimizes the cost by selecting these two transportation options to move grain from surplus producing regions to export points. For the Pacific Coast scenario, the percentage of grain transported on trucks increases significantly to 22% of all shipments, barge traffic declines to 22% of all shipments, and rail traffic as a percentage of all shipments remains unchanged. In addition, the percentage of grain transported by single car rates as a percentage of all rail shipments increases significantly to 46% of the total, while shipments of grain by multi-car and train load rates decline to 14% and 40% of the total, respectively, relative to those of the baseline model (Tables 12 and 18). Changes in the grain flow patterns to the West Coast eliminate some of the barge traffic and train load shipments. The latter occurs because train load rates are typically unavailable for transporting grain from the Corn Belt to the West, a factor which could change by 1990.

The increase in rail rates by 20% relative to those of the baseline model did not change the demand for transportation services. In addition, this scenario does not decrease the percentage of grain transported by rail to export points relative to the baseline scenario; however, truck shipments decline to 7% of the total and barge shipments increase to 37% of all shipments (Tables 12 and 18). This scenario also alters shipments of grain by type of railroad rate, increasing single car shipments to 36% of the total while decreasing multi-car shipments to 14% of the total and train load shipments to 50% of all railroad shipments. By re-examining the domestic shipments, it may be observed that this scenario primarily affects selection of modes within the domestic grain deficit sector. For the two barge scenarios, truck shipments as a percentage of total shipments remained unchanged while barge shipments declined to 25% of the total and railroad shipments increased to 65% of all shipments. The percentage of total shipments by rail (single, multi-car, or train load) is relatively consistent with that reported for the baseline model (Tables 12 and 18). Obviously the increase in barge rates causes the model to substitute rail shipments for barge shipments. The rail abandonment scenario increases the volume of grain moved on trucks to 13% of the total, while rail shipments declined to 53% of the total and barge shipments remained unchanged relative to the baseline model. Since single car rates are deleted from the Corn Belt, grain shipments are transferred from single rail cars to multi-car and train load rates. For example, grain shipments as a percentage of total rail shipments decline to 25% for single car rates and increase to 21% of the total for multi-car and 54% of the total for train load rates (Tables 12 and 18).

The total demand for transportation services for the production and alcohol scenario remains unchanged relative to the baseline model, while the demand for such services decreases when the export reduction and alcohol scenario is introduced. For the production and alcohol scenario, truck shipments as a percentage of all shipments are unchanged relative to the baseline model, the percentage of shipments by barge decreases to 32% of the total, and rail shipments increase to 58% of the total (Tables 12 and 18). The distribution of shipments by type of rail rate is comparable to the distribution for the baseline model (Table 18). For this scenario, barge traffic becomes less important relative to rail shipments because more grain is shipped to grain deficit regions relative to export points. Since most grain deficit regions do not have access to barge facilities, the model minimizes cost by transporting grain to the alcohol plants via the railroad. For the export reduction and alcohol scenario, truck shipments as a percentage of the total increase to 12%, barge shipments are unchanged, and rail shipments decline to 54% of all shipments relative to the baseline scenario. In addition, single car shipments increase to 37% of the total rail shipments, while multi-car and train load shipments decline to 14% and 49% of the total, respectively (Table 18). These changes seem somewhat surprising relative to those for the previous solution. However, a smaller quantity of grain is now available to meet the respective demands, grain exports are reduced, and most demand centers are closer to the supply of surplus grain. The latter permits the model to ship more grain via truck and single car rates to minimize all transportation costs.

Because more grain is stored and less is transported to export points, the demand for transportation services decreases when the storage scenario is introduced. Further, the percentages of grain transported by truck and rail to export points decline to 8% and 48% of the total, respectively, while barge shipments increase to 44% of the total relative to the baseline model. Finally, single car rail shipments as a percentage of all railroad shipments increase to 44% of the total, while multi-car and train load rate shipments decline to 14% and 42% of the total, respectively (Tables 12 and 18).

For the baseline scenario, firms located in the Corn Belt, Lake States, North Plains, South Plains, Delta, Mid-South, Mid-Atlantic and South Atlantic grain surplus regions shipped grain to the eight export points (Table 11). Corn shipments to export points originated in three areas—the Corn Belt, Lake States, and North Plains surplus grain producing areas (Table 8). Illinois, Indiana, and Ohio supply corn to the Lake, Atlantic, and Gulf ports. All shipments to the Atlantic move by rail, while shipments to the Lake ports move by rail and truck modes. Barge shipments of corn to the Gulf ports originate in the Corn Belt and the Plains grain surplus producing regions (Figures 13 and 14). These grain flow patterns change when the policy scenarios are introduced. For the Pacific Coast scenario, less corn flows by rail from the Corn Belt to the Atlantic and Gulf ports, less corn flows by barge from the Corn Belt and Plains surplus regions to the Gulf ports, while rail shipments to the Pacific Coast originate in Texas and the Lake States grain surplus producing regions (Fig. 15). The increase export scenarios also alter the corn flow pattern. Railroad shipments to Atlantic ports originate in the South as well as in the Corn Belt, rail shipments to the Lake ports originate from the North Plains area, the Lake States, and the Corn Belt, while

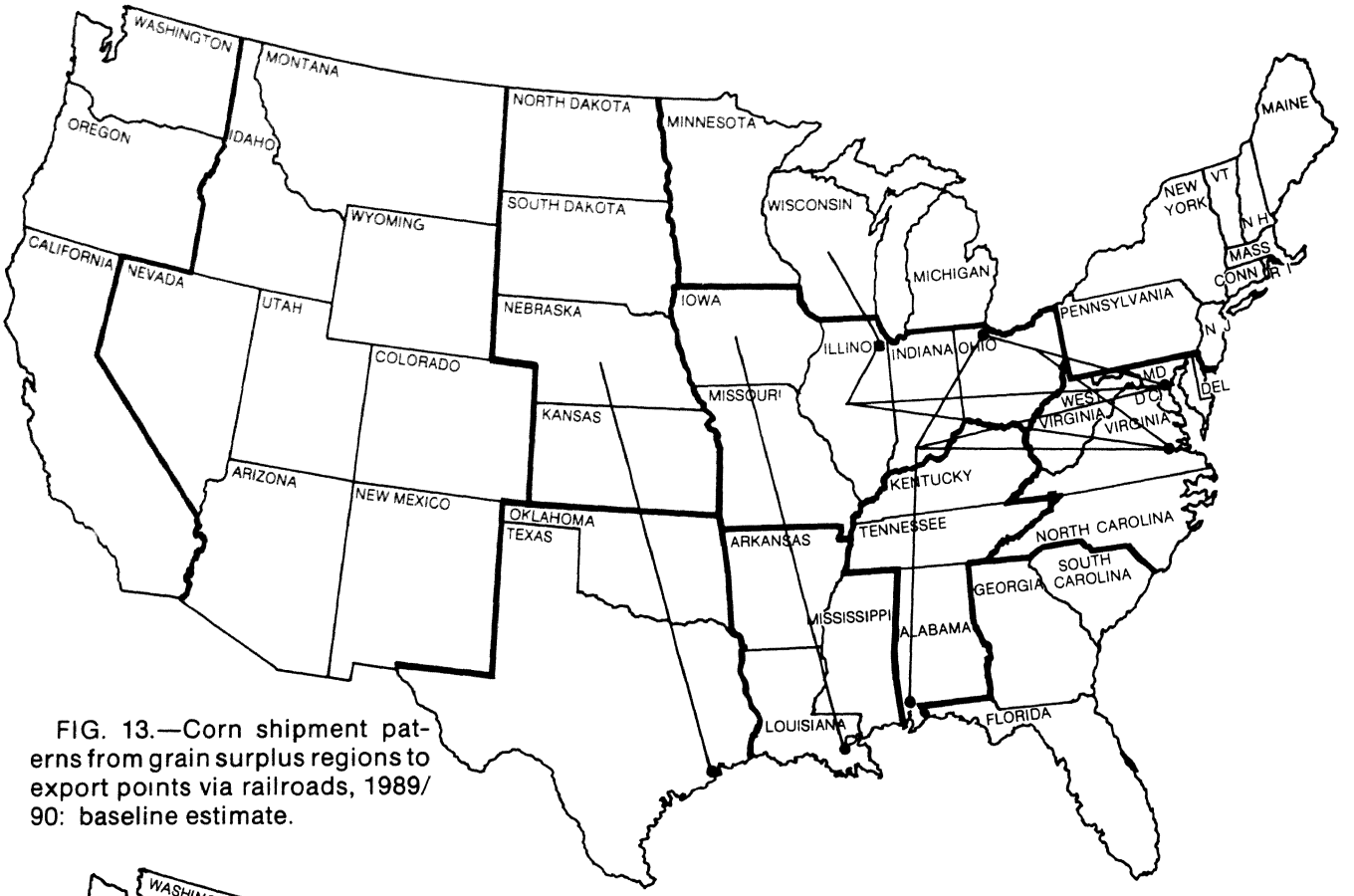

FIG. 13.—Corn shipment patterns from grain surplus regions to export points via railroads, 1989/90: baseline estimate.

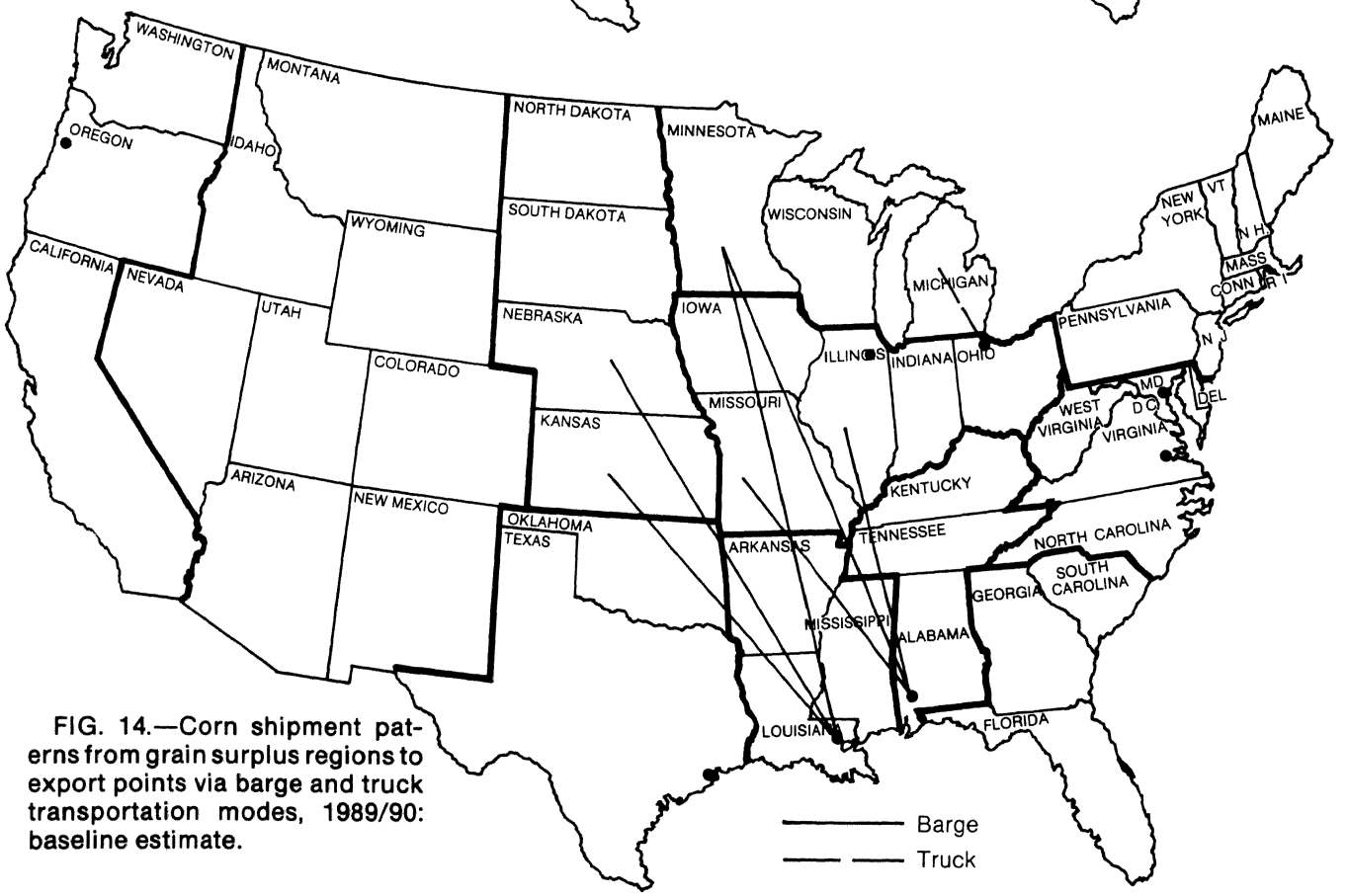

FIG. 14.—Corn shipment patterns from grain surplus regions to export points via barge and truck transportation modes, 1989/90: baseline estimate.

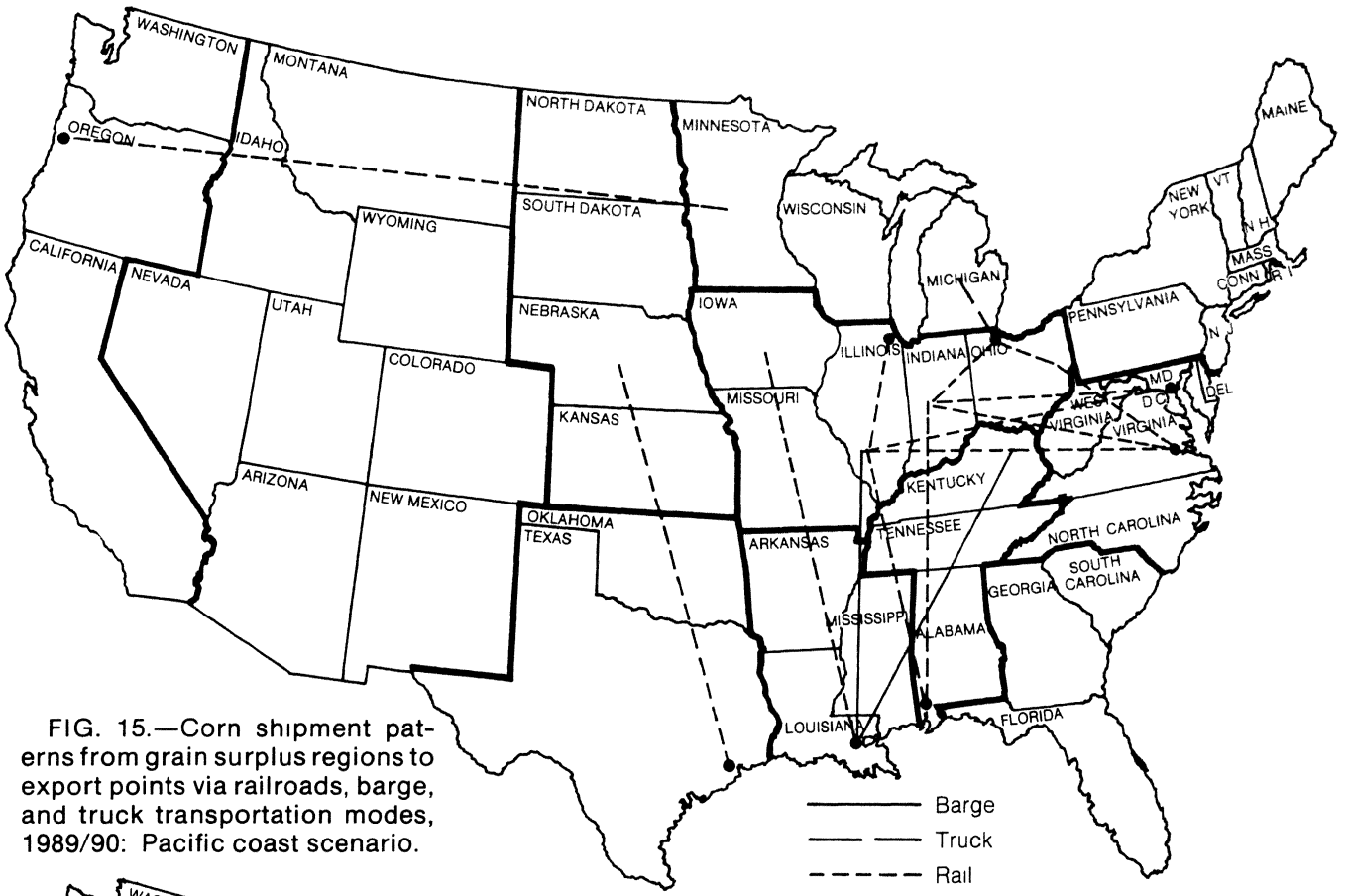

FIG. 15.—Corn shipment patterns from grain surplus regions to export points via railroads, barge, and truck transportation modes, 1989/90: Pacific coast scenario.

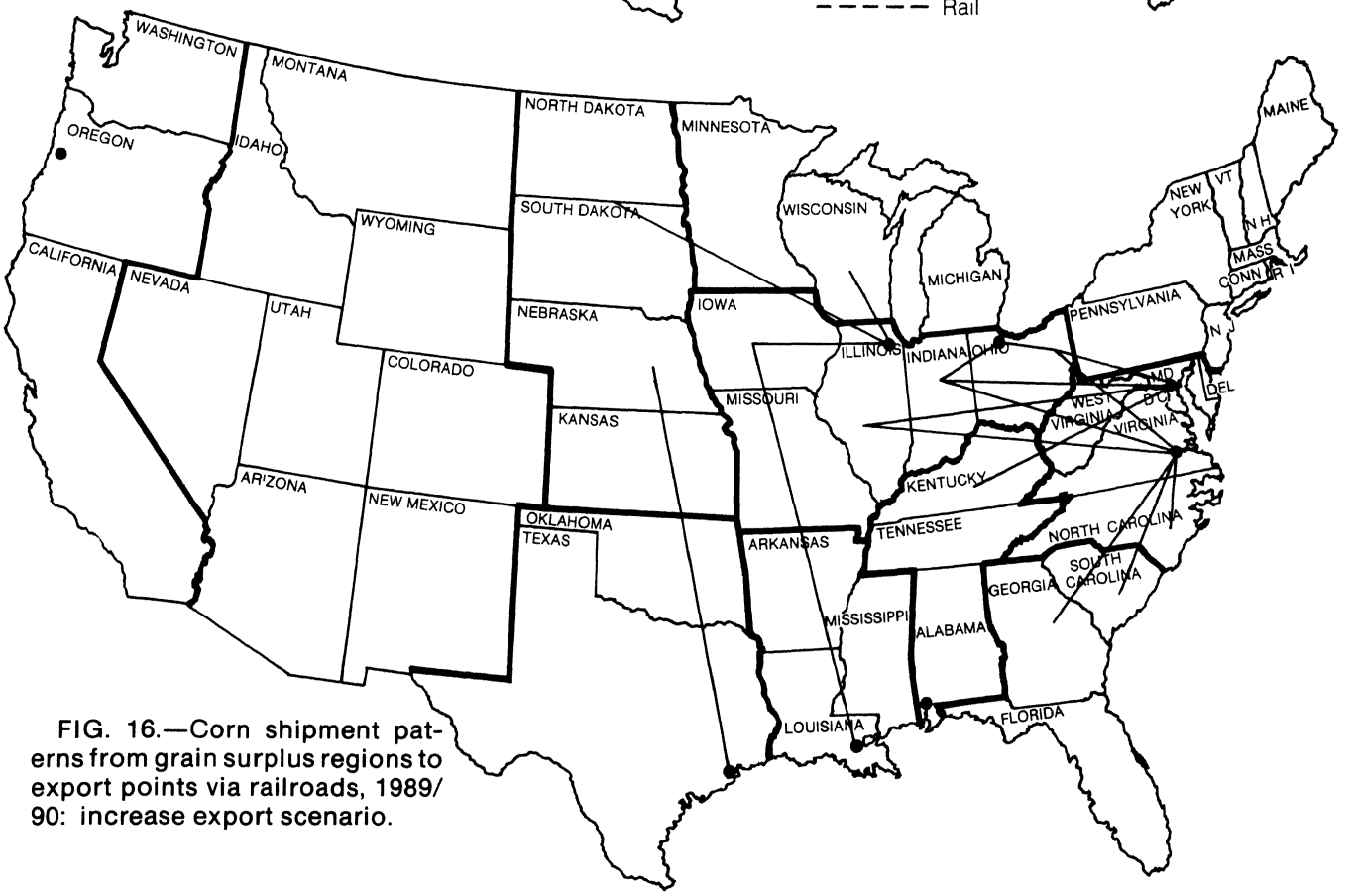

FIG. 16.—Corn shipment patterns from grain surplus regions to export points via railroads, 1989/90: increase export scenario.

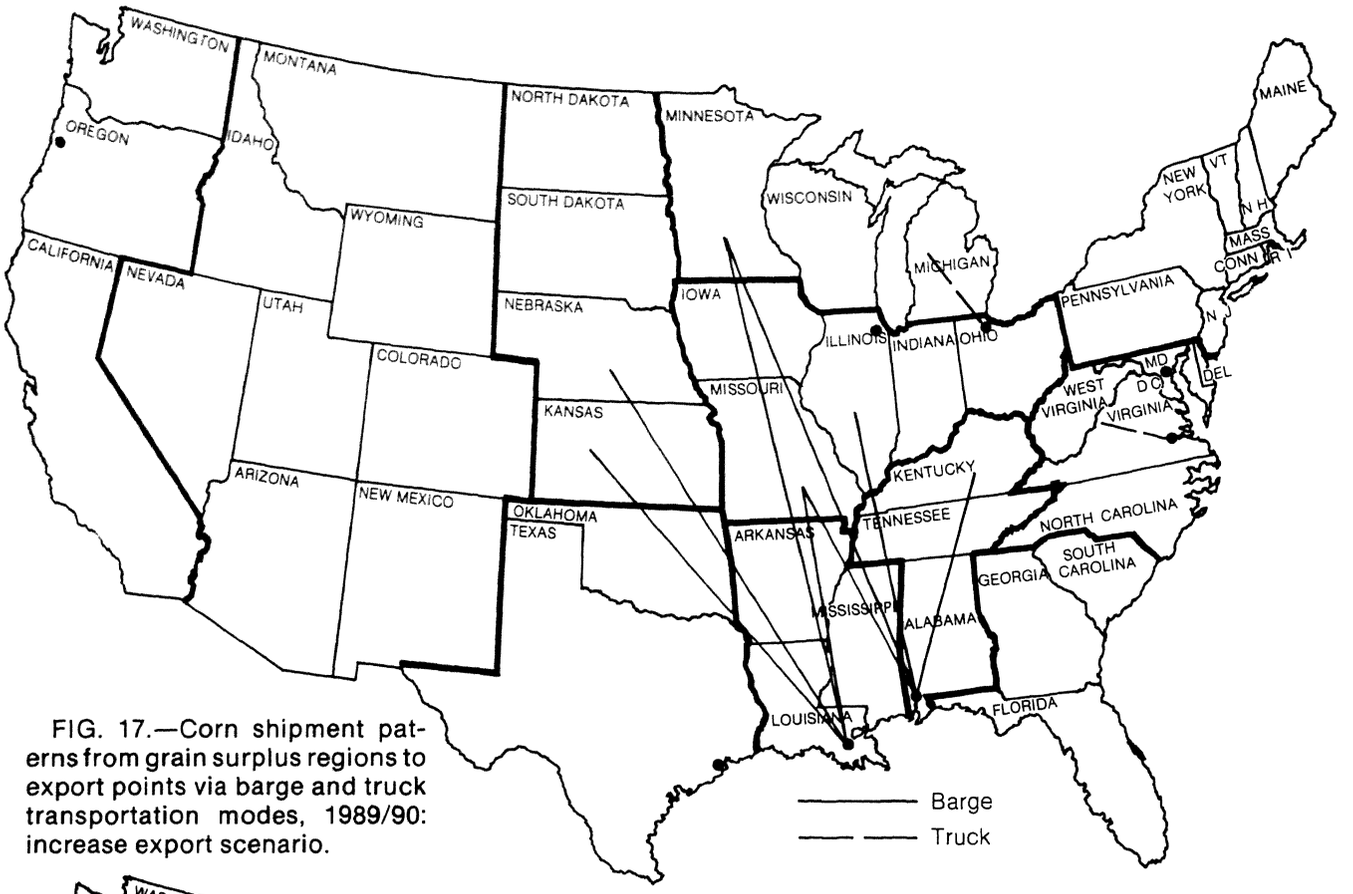

FIG. 17.—Corn shipment patterns from grain surplus regions to export points via barge and truck transportation modes, 1989/90: increase export scenario.

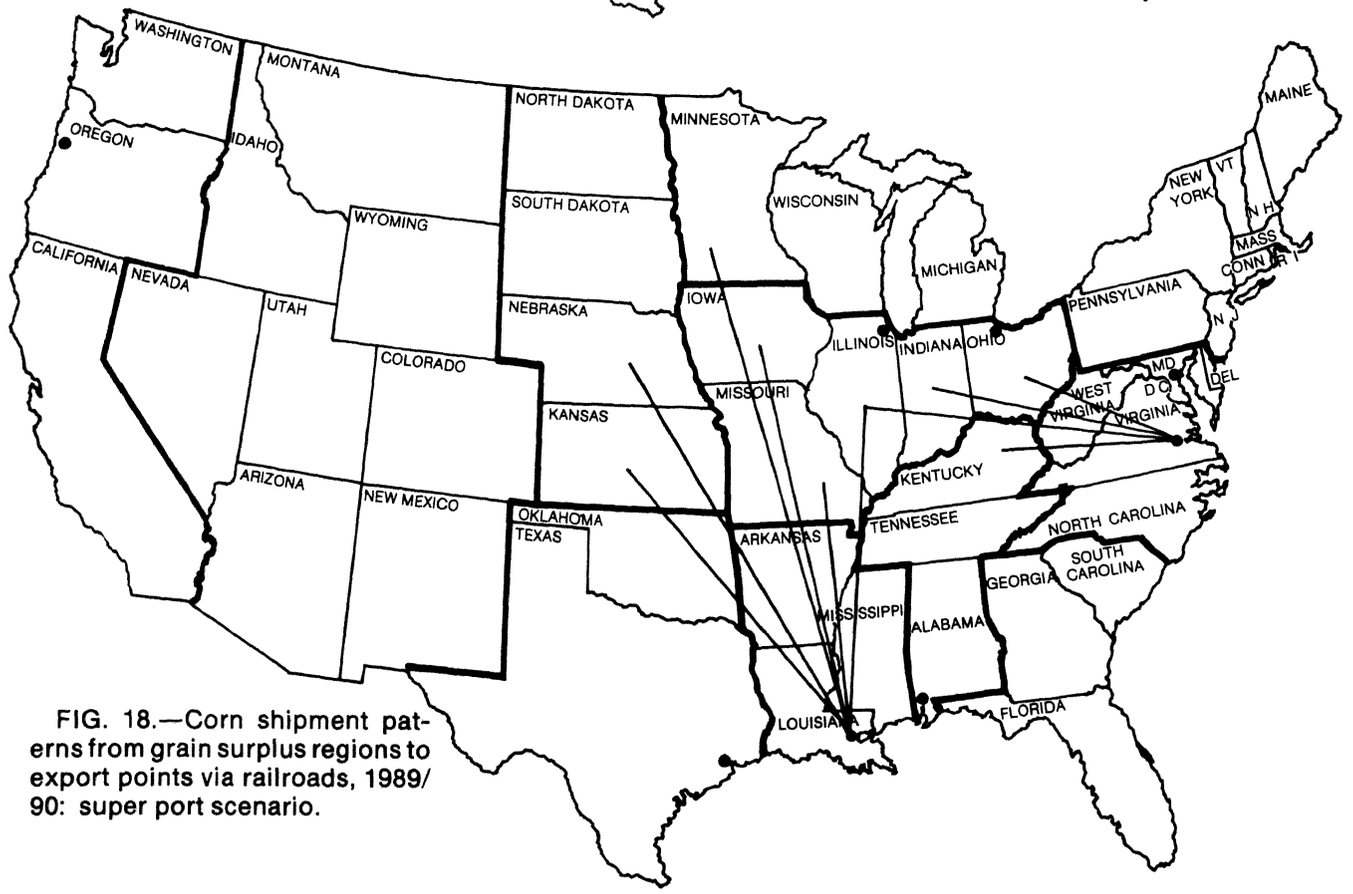

FIG. 18.—Corn shipment patterns from grain surplus regions to export points via railroads, 1989/90: super port scenario.

the numbers of barge routes to the Gulf ports increase from the Plains areas, Lake States, Corn Belt, and the South (Figures 16 and 17). In contrast to the above two export scenarios, the assumptions underlying the super port scenario cause all shipments to flow to the Atlantic, Gulf, or Pacific Coast ports. All Atlantic port exports originate out of the Corn Belt and move on the railroad system, while Gulf port corn exports originate in the Corn Belt, Lake States, and Plains surplus grain producing regions and are transported on the railroad and barge system (Fig. 18).

Since the 20% and 30% increases in barge rate scenarios transfer corn from barge routes to the railroad system, the corn flow patterns change as more corn is shipped by railroad from the Corn Belt to the Atlantic and Gulf ports, more railroad routes emerge from the Plains surplus regions, and fewer barge routes are used to transfer grain from the Corn Belt and Plains regions to the Gulf ports (Figures 19 and 20). The 20% increase in rail rates has little impact on the transportation system and flow pattern for transporting corn to export points, while the rail abandonment scenario decreases the number of railroad routes from the Corn Belt to the Gulf ports and increases the number of barge routes which originate out of the Corn Belt and Plains areas and terminate at the Gulf port. Further, the alcohol scenarios have limited effect on the corn flow patterns to the ports. However, the decrease in volume for the corn export and alcohol scenarios does decrease the number of barge routes which originate within the Plains, Lake States, and Corn Belt and terminate at the Gulf ports. Finally, the storage scenario reduces the volume of corn shipments to all ports, but routes are not significantly altered.

For the baseline scenario, soybean shipments to export points originate in seven areas — the Mid-Atlantic, South Atlantic, Mid-South, Delta, Corn Belt, Lake States, and North Plains grain producing regions. Most shipments (55%) originate in the Corn Belt, while the Delta and Lake States regions ship an additional 13% and 11% of all shipments, respectively. The remaining 21% of all shipments to export originate from the other four grain producing regions (Table 9). All shipments to the Atlantic port move by rail and originate in the Corn Belt and South; shipments to the Lake ports move by truck and rail modes and originate in the Lake States and Corn Belt grain producing regions; shipments to the Gulf move by rail and barge modes and originate in the Corn Belt, Lake States, Plains, and South; and soybean shipments to the Pacific port move by rail, originating in the Lake States (Figures 21 and 22).

The soybean grain flow patterns also change when the policy scenarios are introduced. For the Pacific port scenario, the number of railroad and barge routes originating in the Corn Belt and terminating at the Gulf ports decreases while the number of similar routes to the Pacific port increases. The increase in export and super port scenarios increases the number of railroad and barge routes originating in the South and terminating at the Gulf ports (Figures 23, 24, 25, and 26). The 20% and 30% increases in barge rate scenarios also increase the number of rail routes originating in the South and terminating at the Gulf, and reduce the number of all barge routes. In addition, the 20% increase in rail rate scenario did not alter the number of rail routes or barge routes, but more truck routes appear in the South and terminate at Gulf ports. Finally, the rail abandonment scenarios do not have a significant impact on the number or type of transportation routes, while the storage scenario reduces the number of routes and directional flow of soybeans. Small quantities of soybeans are shipped by rail to the Atlantic Coast from the Corn Belt and South, and small quantities move by rail to the Gulf from the South. Larger quantities are shipped by barge from the Corn Belt and South to the Gulf ports.

For the baseline model, wheat shipments to all export points originate in six grain producing regions — South Plains, Lake States, Corn Belt, Delta, Mid-South, and North Plains. Approximately 46% of all shipments originate in the South Plains area, 31% in the Lake States, and 12% in the Corn Belt. The remaining 11% of all shipments originate in the other three production areas (Table 10). All shipments to the Atlantic ports move by railroad and originate in the Corn Belt. Exports to the Lake ports originate in the Corn Belt and are transported by rail and truck. Shipments to the Gulf ports originate in the Corn Belt, South, Lake States, and Plains regions and are transported on the railroad and barge system. Finally, shipments to the Pacific ports move by rail and originate in Texas (Figures 27 and 29).

Since the volume of wheat shipped to the Pacific port does not increase for the Pacific Coast scenario, shipment patterns and distribution of shipments among transportation modes are not changed. However, the introduction of other policy scenarios does change these variables. For example, the super port scenario increases the number of rail shipments and alters the grain flow pattern, as wheat shipments to the Atlantic ports originate in the Lake States and South, as well as in the Corn Belt. The number of rail shipments to the Gulf decreases as more grain moves on train load rates and less moves via single car rates. The number of barge routes to move grain into the Gulf ports also declines. Shipment patterns to the Pacific ports remain unchanged (Figures 29 and 30). The introduction of the increase export scenario does not alter the number of transportation routes or the grain origin areas; instead, more total wheat shipments occur.

The 20% increase in rail rate scenario has a major impact on the number of rail and barge shipments and the grain flow patterns for wheat. The Atlantic ports acquire rail shipments of wheat from the Plains area as well as the Corn Belt. Rail shipments into the Gulf ports do not change; however, barge shipments into the Gulf Ports originate in the Lake States, Plains areas, Corn Belt, and South. The shipment pattern and transportation modes do not change for wheat movements to the Pacific ports (Figures 31 and 32). Predictably, the barge rate scenario increases rail shipments, decreases barge shipments, and alters grain flow patterns (Fig-

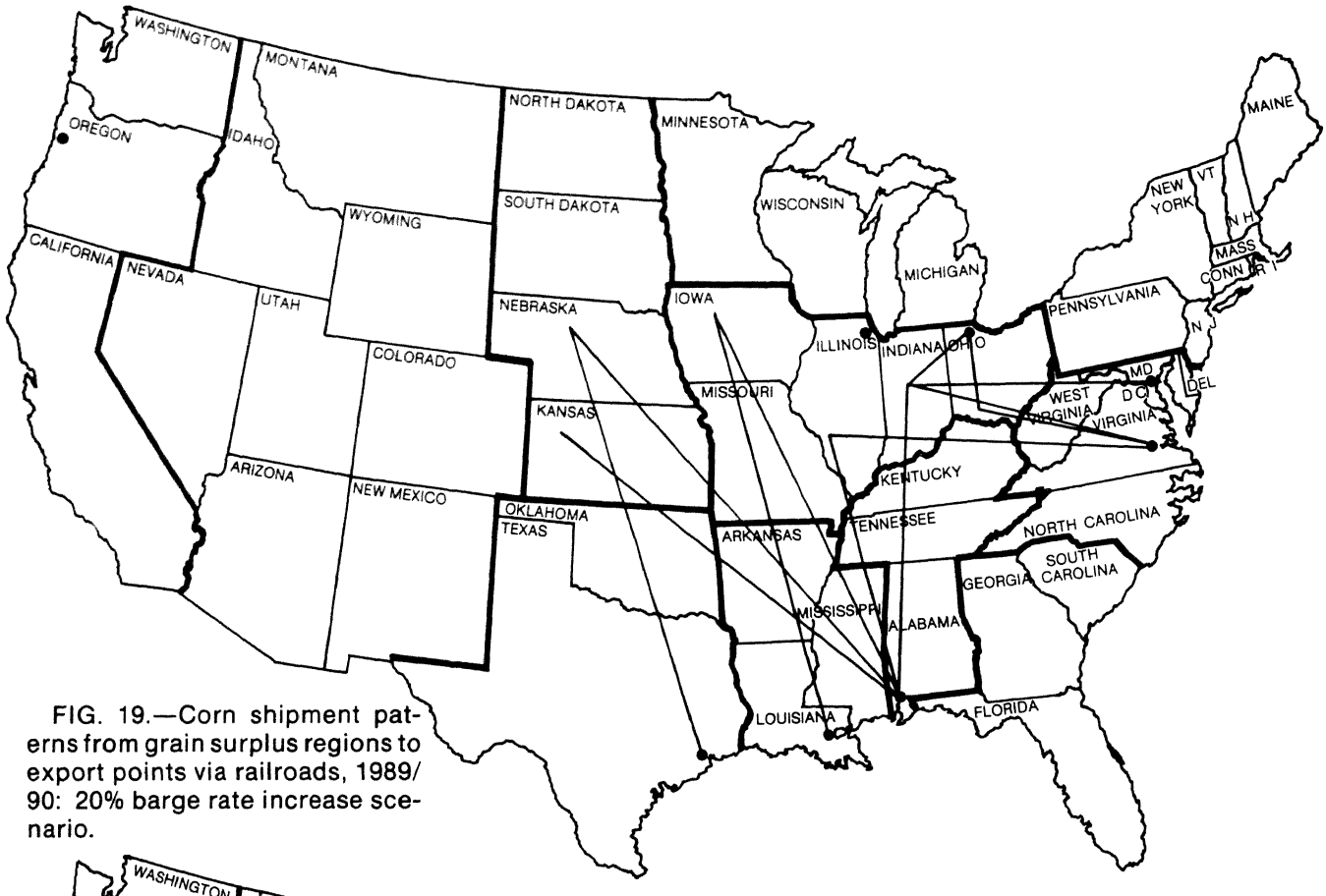

FIG. 19.—Corn shipment patterns from grain surplus regions to export points via railroads, 1989/90: 20% barge rate increase scenario.

FIG. 20.—Corn shipment patterns from grain surplus regions to export points via barge and truck transportation modes, 1989/90: 20% barge rate increase scenario.

FIG. 21.—Soybean shipment patterns from grain surplus regions to export points via railroads, 1989/90: baseline estimate.

FIG. 22.—Soybean shipment patterns from grain surplus regions to export points via barge and truck transportation modes, 1989/90: baseline estimate.

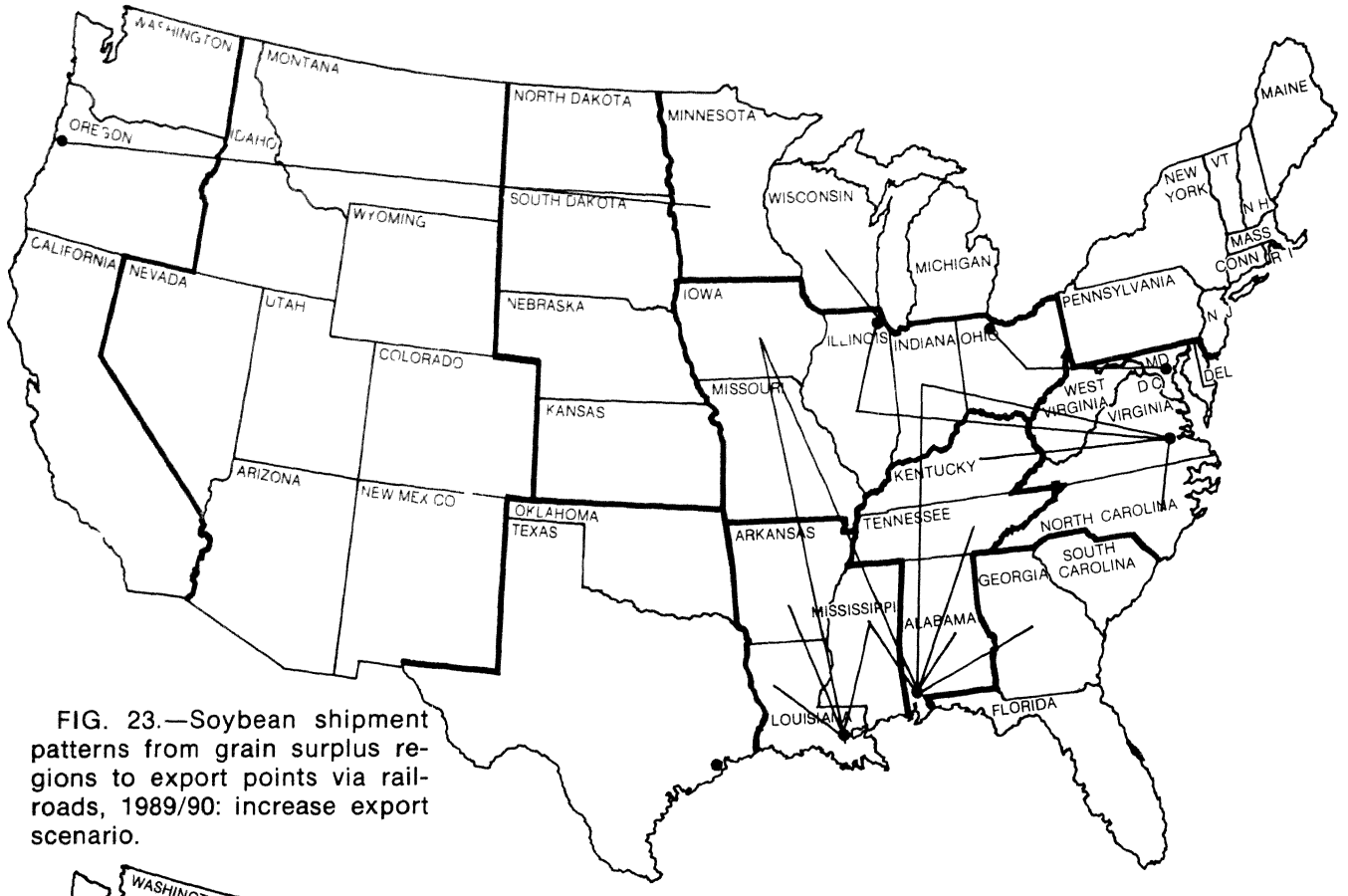

FIG. 23.—Soybean shipment patterns from grain surplus regions to export points via railroads, 1989/90: increase export scenario.

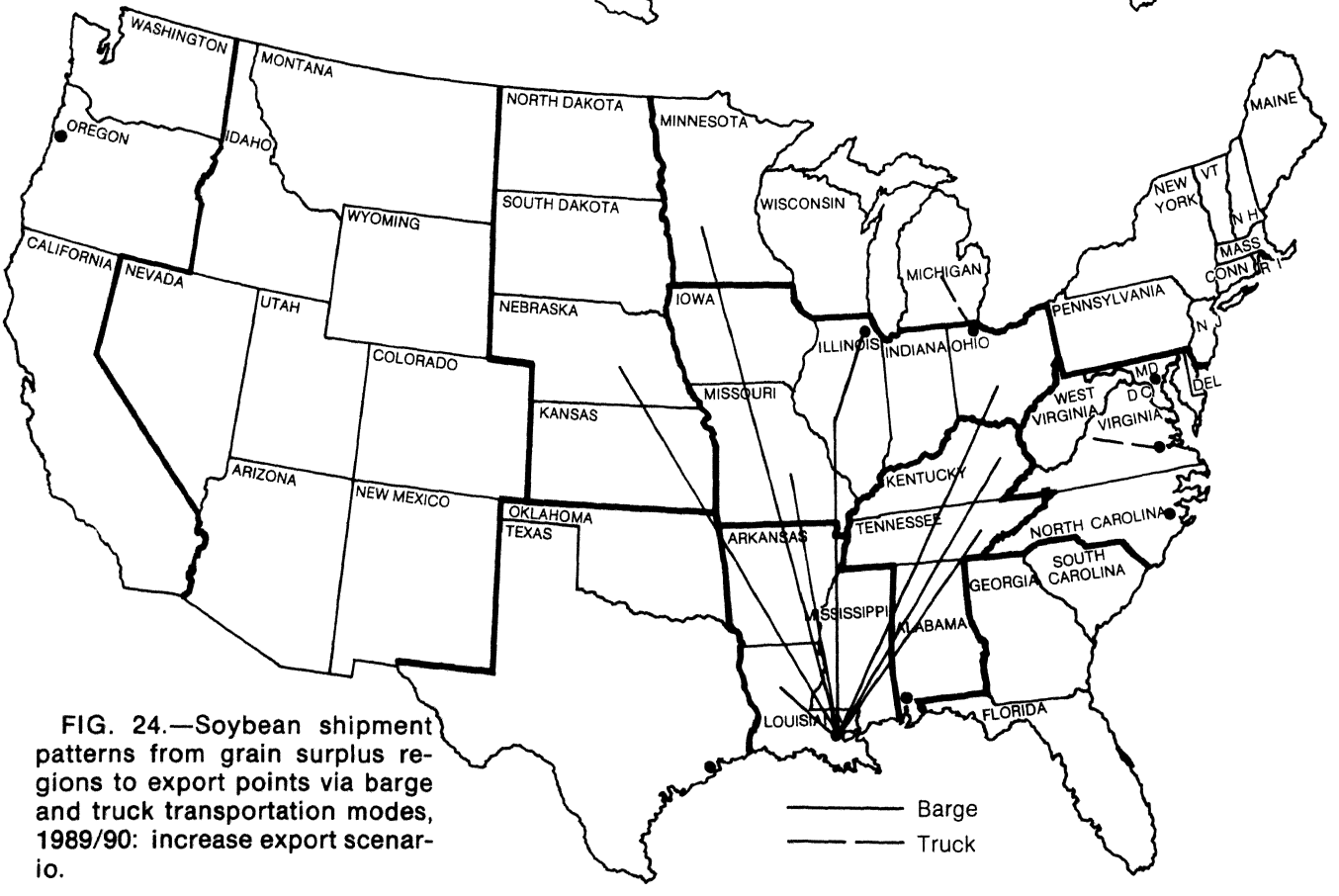

FIG. 24.—Soybean shipment patterns from grain surplus regions to export points via barge and truck transportation modes, 1989/90: increase export scenario.

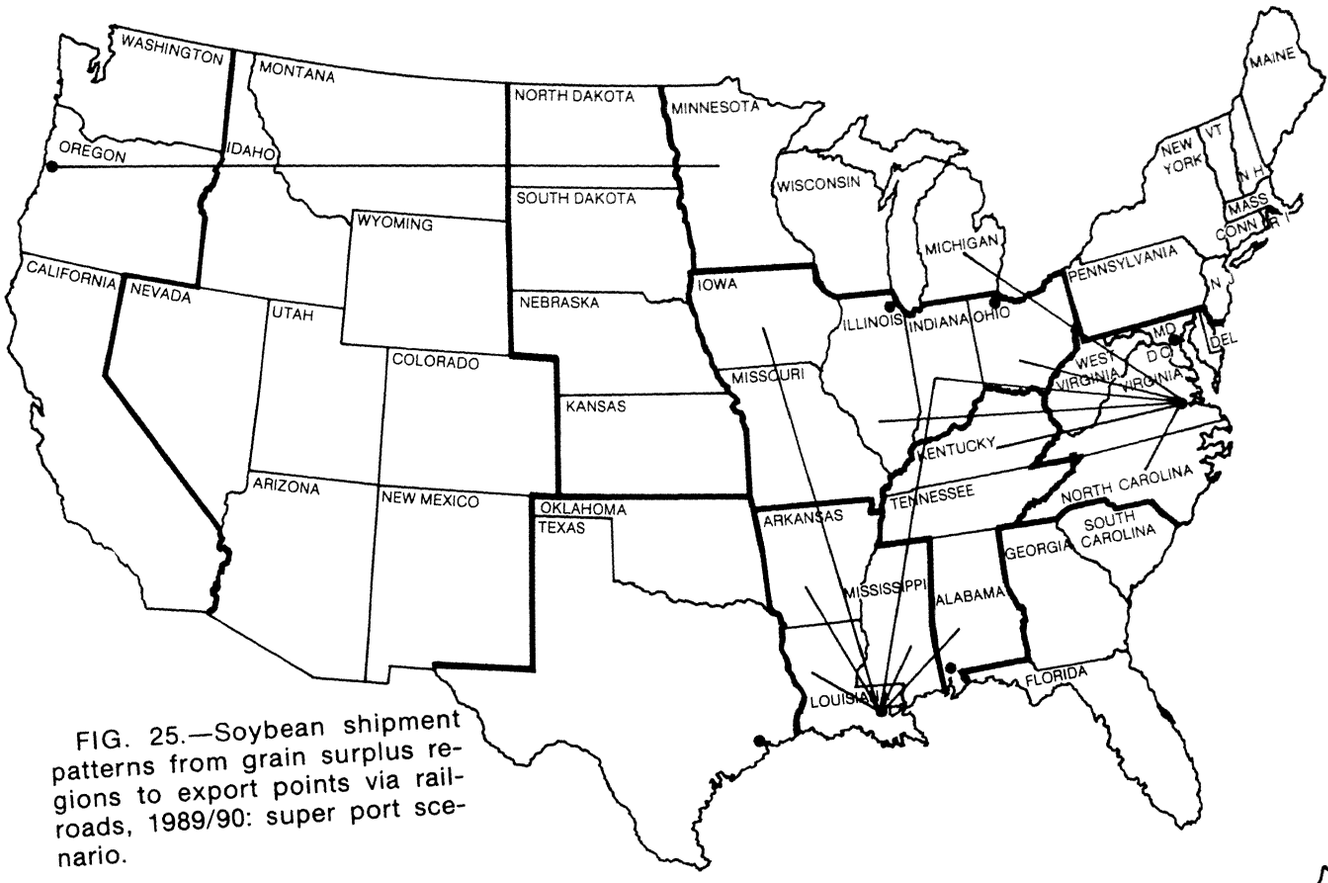

FIG. 25.—Soybean shipment patterns from grain surplus regions to export points via railroads, 1989/90: super port scenario.

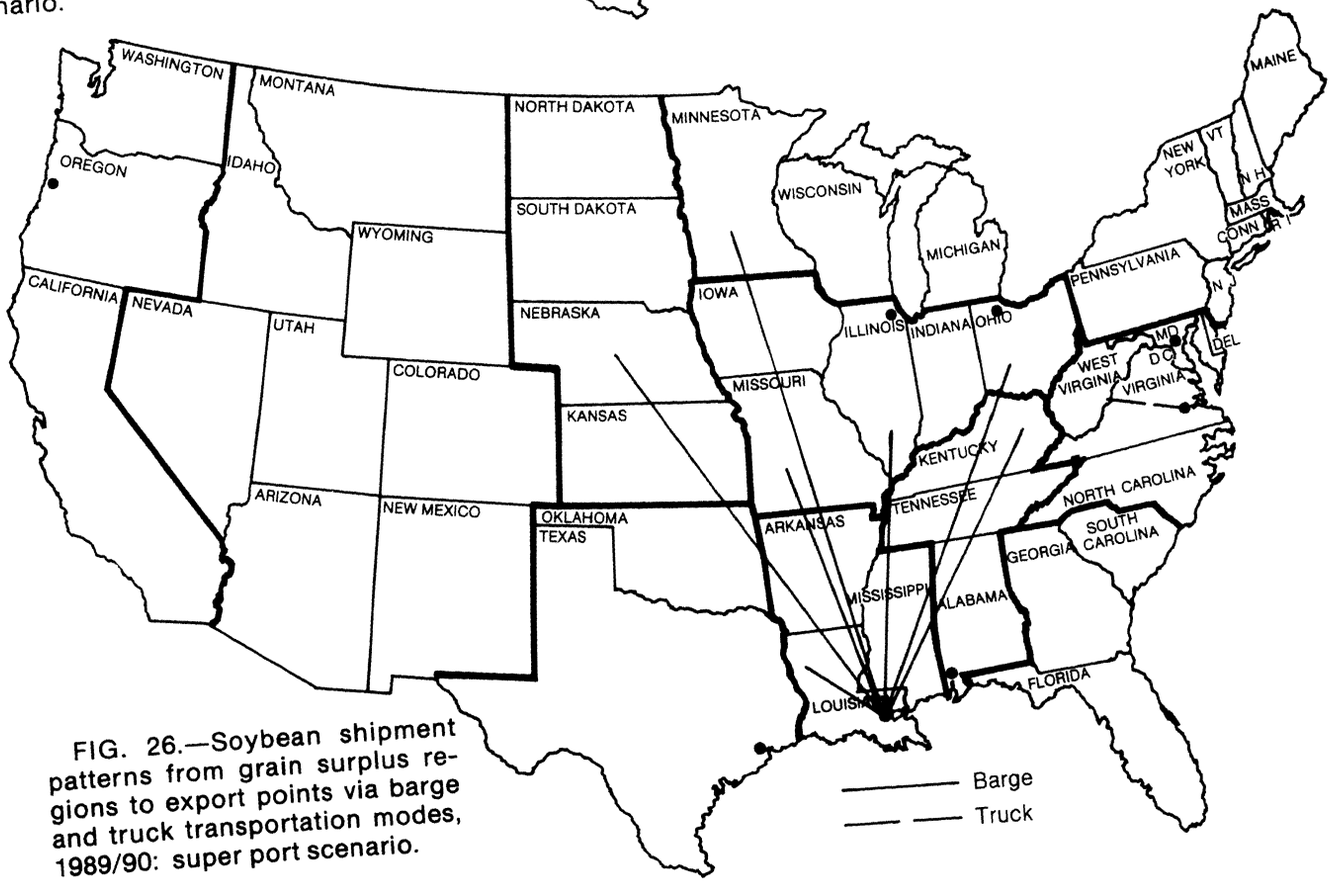

FIG. 26.—Soybean shipment patterns from grain surplus regions to export points via barge and truck transportation modes, 1989/90: super port scenario.

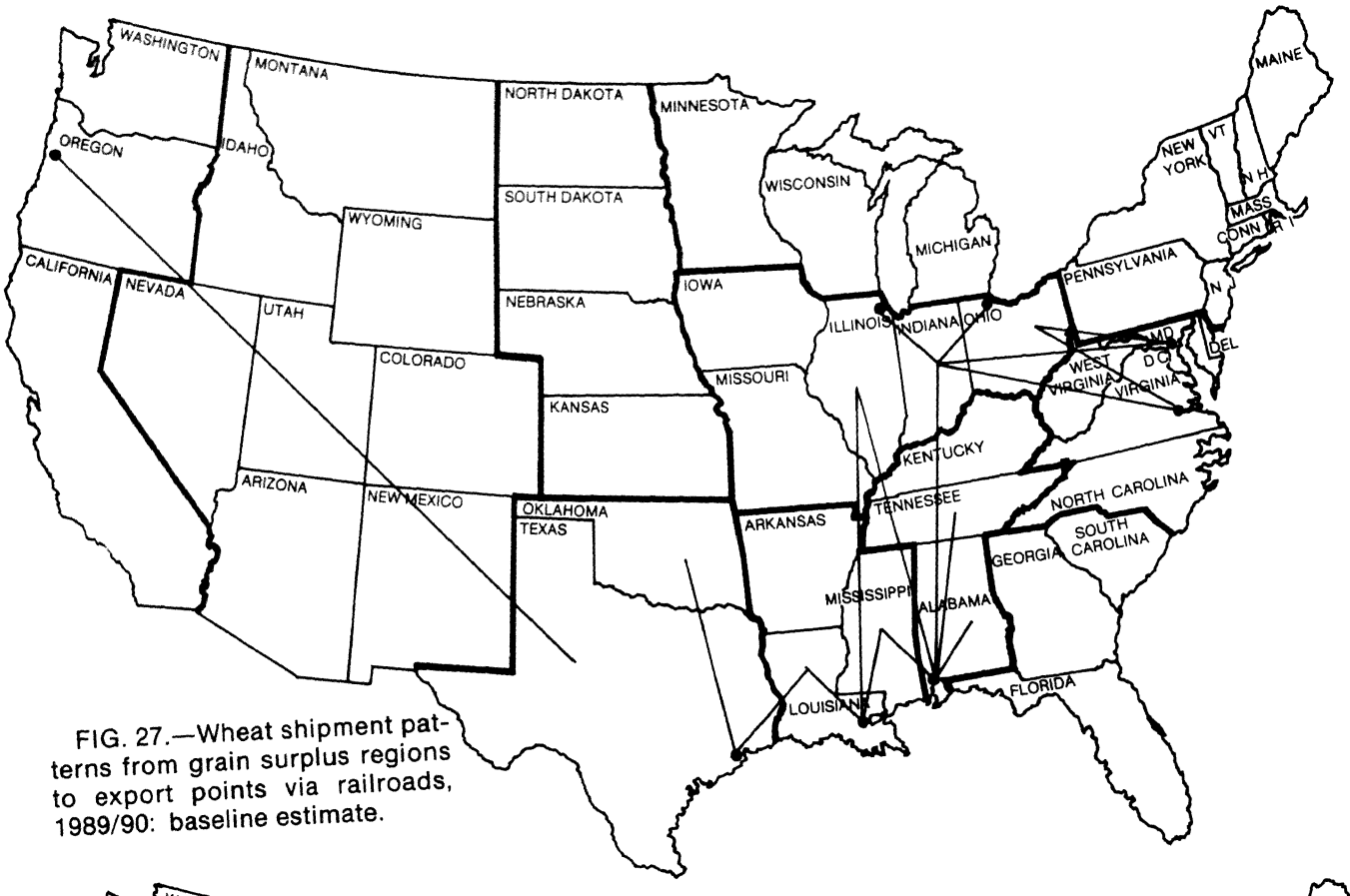

FIG. 27.—Wheat shipment patterns from grain surplus regions to export points via railroads, 1989/90: baseline estimate.

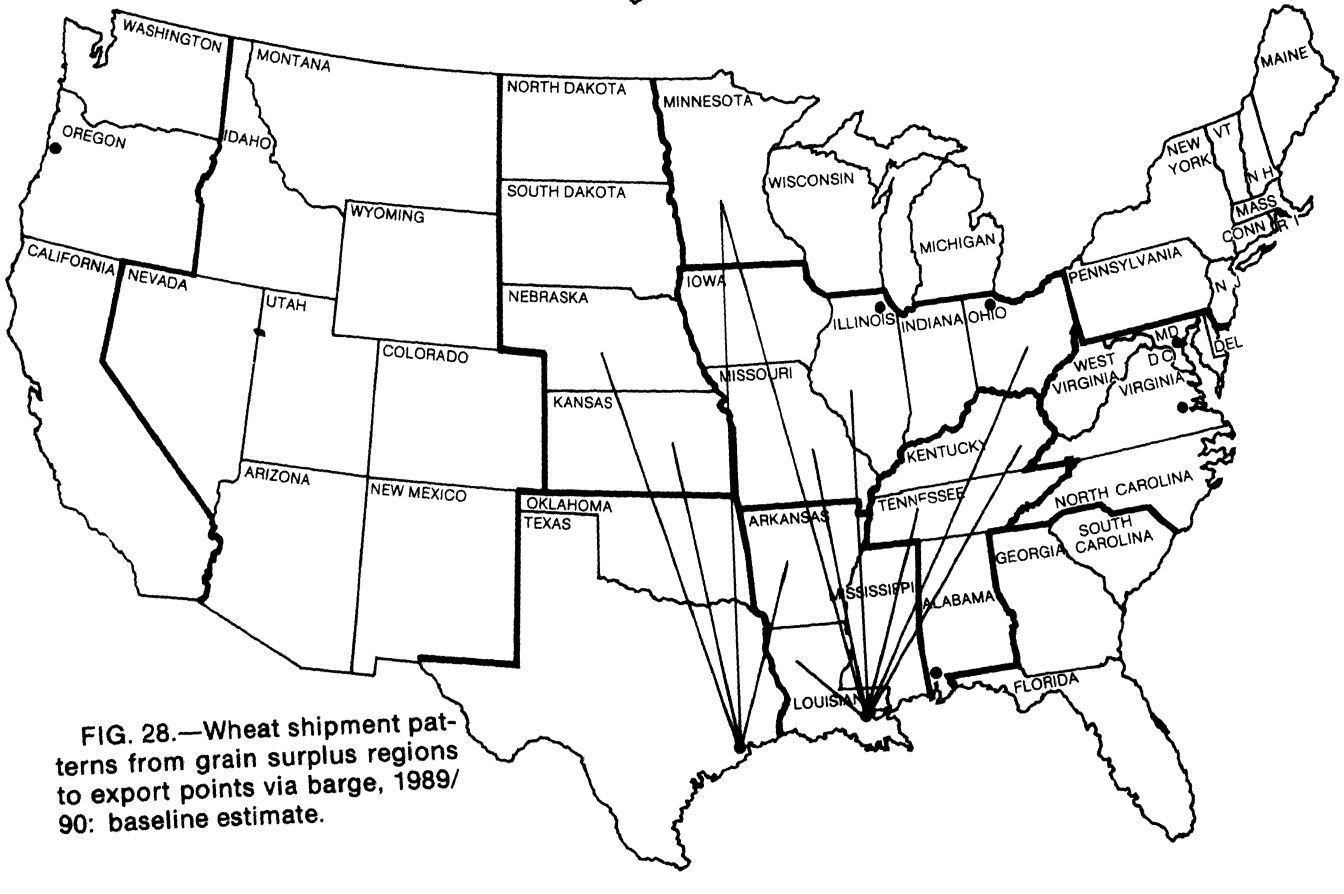

FIG. 28.—Wheat shipment patterns from grain surplus regions to export points via barge, 1989/90: baseline estimate.

FIG. 29.—Wheat shipment patterns from grain surplus regions to export points via railroads, 1989/90: super port scenario.

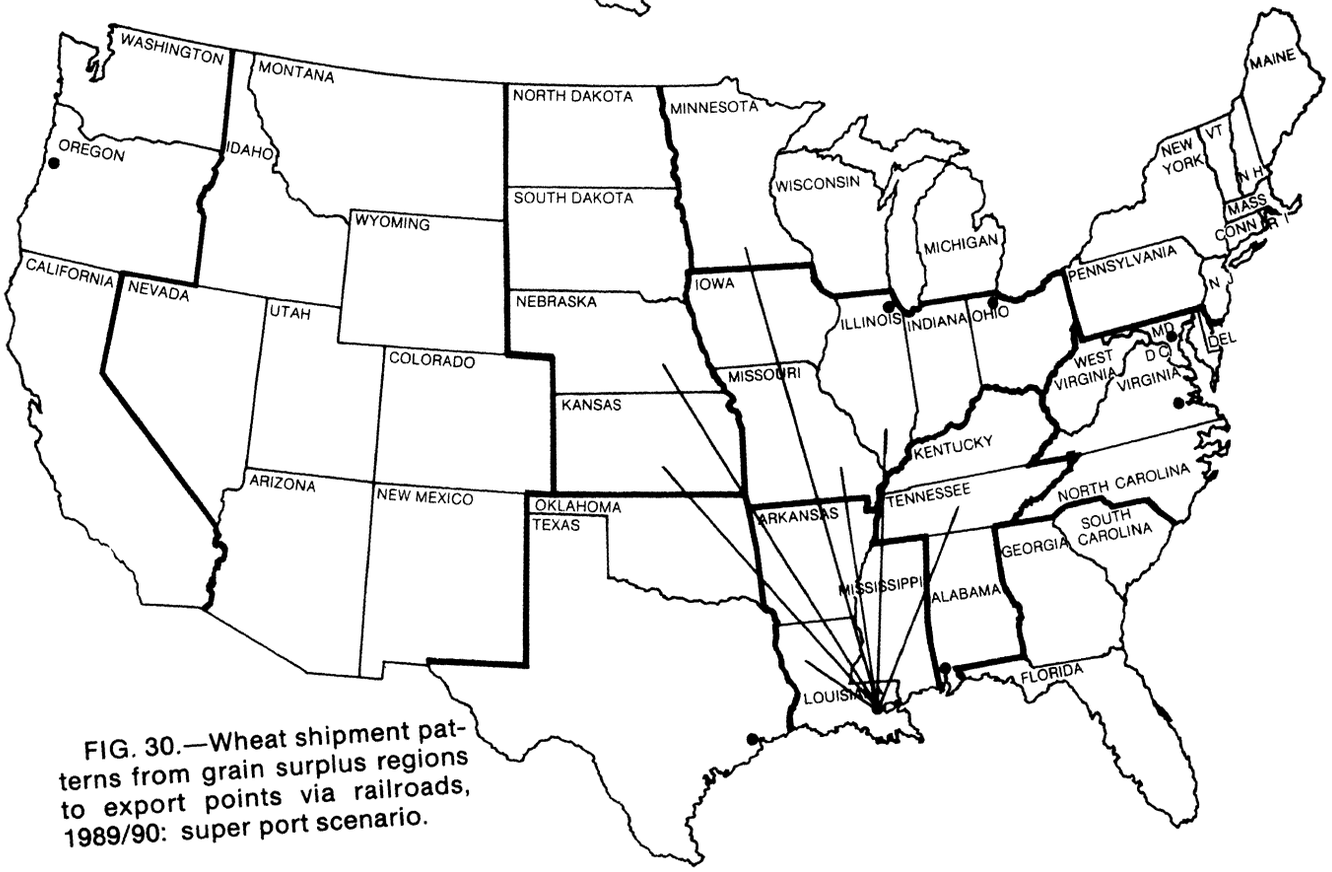

FIG. 30.—Wheat shipment patterns from grain surplus regions to export points via railroads, 1989/90: super port scenario.

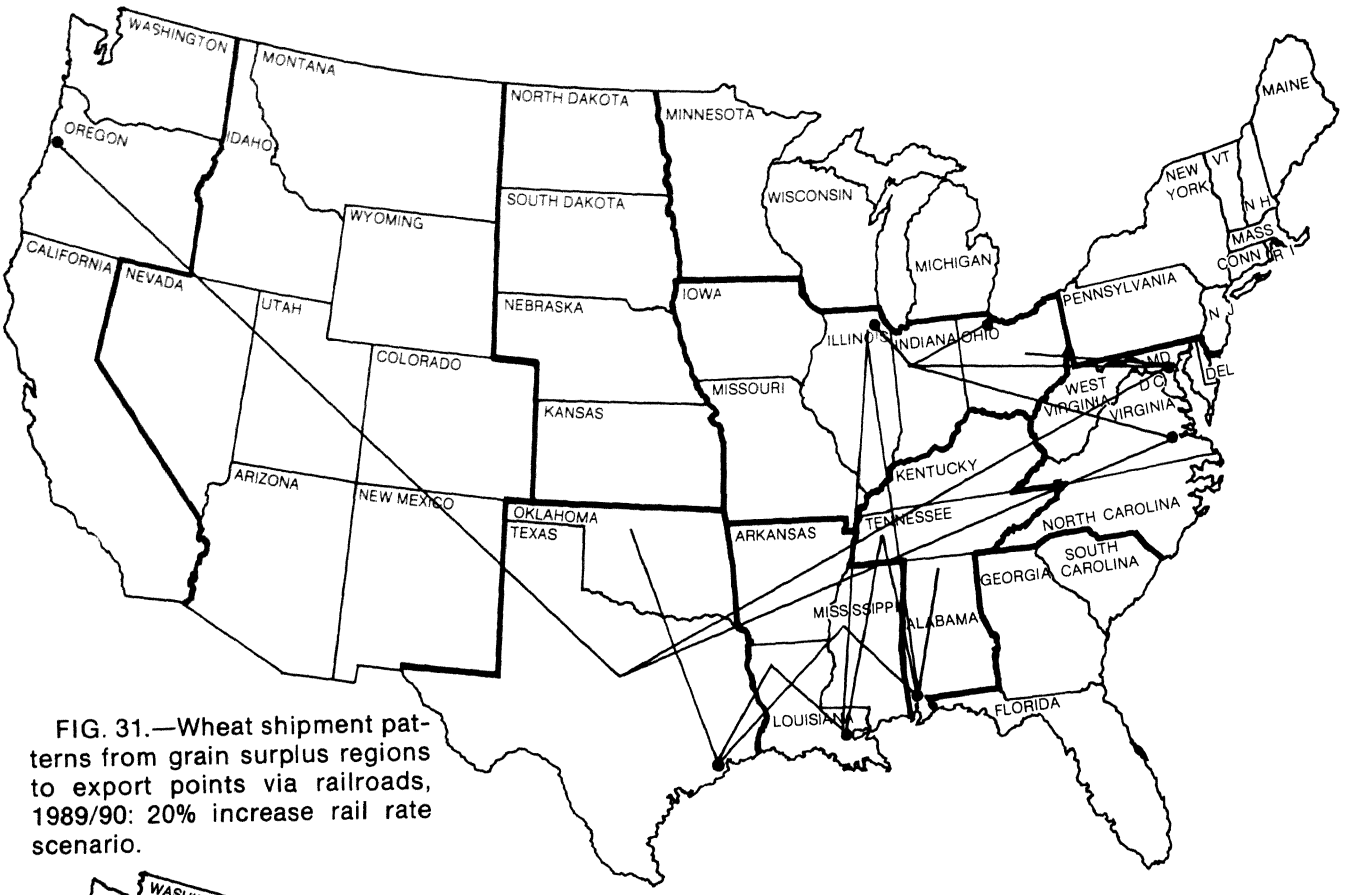

FIG. 31.—Wheat shipment patterns from grain surplus regions to export points via railroads, 1989/90: 20% increase rail rate scenario.

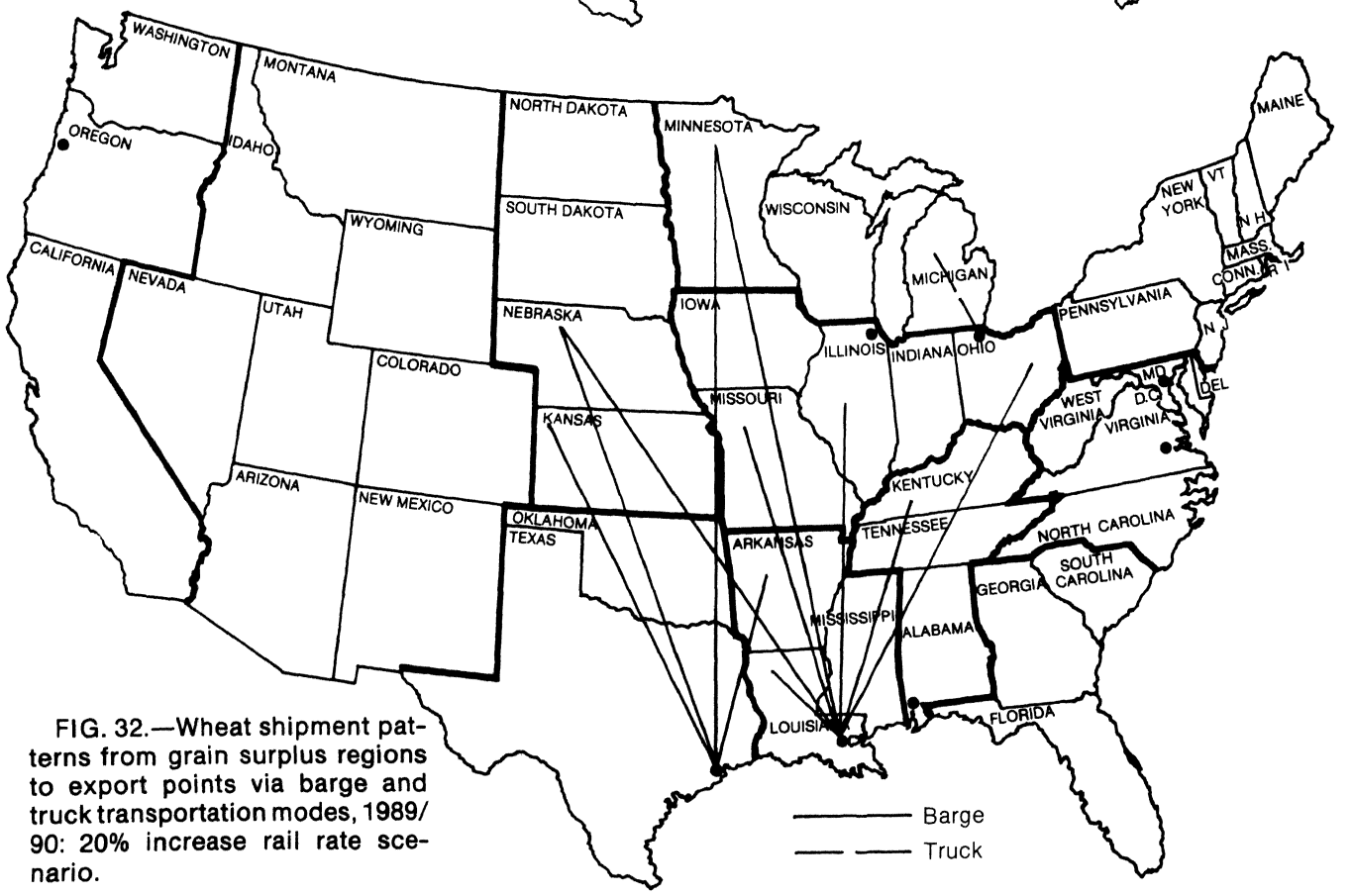

FIG. 32.—Wheat shipment patterns from grain surplus regions to export points via barge and truck transportation modes, 1989/90: 20% increase rail rate scenario.

ures 33 and 34). The rail abandonment scenario has only limited impact upon shipment patterns and modes. Finally, the storage scenario reduces the number of rail shipments and alters the directional flow of barge movements.

Grain Storage for Baseline Estimates and Ten Policy Scenarios

Since grain is shipped to deficit regions and export points throughout the year and is stored or "carried over" into the following crop year, firms must store grain after the harvest to meet future demands. To simulate this important marketing function, the model stores grain through two time periods, July to December and January to June.[10] What follows is an examination of the volume of grain stored by time period, region, and firm for the baseline estimates and the ten policy scenarios.

The bushels of grain stored in the first period (July to December) are exogenously determined by the grain supply and demand constraints. That is, carryover into the second period (January to June) from the first period must equal the total supply of grain minus the demand for grain in the first period. For the baseline estimate, 5 billion bushels of grain are stored in the 11 production regions during the first storage period; 46% of the total is stored in the Corn Belt, 22% is stored in the North Plains, 14% is stored in the Lake States, 5% is stored in the Delta, and 5% is stored in the South Plains. Only 8% is stored in the remaining six production regions (Table 19). Nearly 99% of the grain is stored by elevators within the regions in which the grain is produced. Less than 1% is stored by processing firms and none is stored at export points or on farms.[11] In the first period, exporters acquire grain to meet first period demands and do not acquire grain for carryover to the second period. Since this model did not include grain storage for intra-regional shipments and processing demands or federal government subsidies for storing grain, farmers are not performing a significant part of national grain storage.

Because large quantities of corn are produced and are shipped to export points and grain deficit regions relative to soybeans and wheat, approximately 54% of all stored grain is corn. In contrast, smaller quantities of soybeans (22% of total storage) and wheat (24% of the total) are stored. Most of the corn is stored in three grain production regions — the Corn Belt, Lake States, and North Plains; most of the soybeans are also stored in three regions — the Corn Belt, Delta, and Mid-South; while wheat is more evenly distributed among five regions — the Corn Belt, North Plains, Lake States, Delta, and South Plains areas (Table 19).

The volume of grain stored and the regions within which it is stored change when the policy scenarios are introduced. However, grain elevators store more than 99% of all grain in the first time period for all scenarios, a finding which is consistent relative to the baseline estimates. For the increase export scenario, the volume of grain stored increases to 6.3 billion bushels, a 28% increase relative to the baseline model (Table 19). This increase occurs because grain surpluses and shipments to export points increase for the export scenario relative to the baseline estimate (Table 5). Most grain is again stored in three regions — the Corn Belt, Lake States, and North Plains; however, the percentage of grain stored in these three regions declines relative to that stored in the other eight production regions. For the individual grains, more corn is stored in the Lake States regions and less is stored in the North Plains area; more soybeans are stored in the Delta, Mid-South, and Mid-Atlantic regions relative to the other production regions; and more wheat is stored in the Lake States relative to the other production areas. This redistribution among regions occurs whenever more grain is stored and occurs in the regions in which additional grain surpluses appear.

For the storage scenario, the volume of grain stored in the first time period also increases to 7.1 billion bushels, a 43% increase relative to the baseline estimate (Table 19). This increase in stored grain is not surprising as export demands are diminished by 50% for this scenario. Most of the grain (86% of the total) is stored in the Corn Belt, Lake States, and North Plains area. Most of the corn and soybeans is stored in the Corn Belt, while most of the wheat is stored in the North Plains area. Like all other scenarios and the baseline estimate, 99% of the grain is stored in elevators and in the regions where it is produced.

The volume of grain stored in the first period increases to 6 billion bushels for the production and alcohol scenario relative to the baseline estimate (Table 19). This is a 21% increase in the volume of stored grain and occurs because more grain is produced to meet the increase in demand by alcohol processors; 80% of all grain is stored in the Corn Belt and North Plains areas. The Lake States are no longer a significant grain storage area as transshipments decrease. Not surprising, most of the corn is stored in the Corn Belt while storage patterns for soybeans and wheat are unchanged relative to the baseline estimate.

For the remaining seven scenarios, the volume of grain stored in the first time period equals the comparable volume stored for the baseline estimate. Any differences are due to rounding errors (Table 19). In addition, grain is again stored at elevators and in the regions in which it is produced. Finally, most of the grain is stored in the Corn Belt, North Plains, and Lake States production regions.

For the super port scenario and the 20% increase in rail rate and barge rate scenarios, most changes in storage patterns among regions are insignificant and are probably due in part to rounding errors. For the Pacific Coast scenario, the volume of corn stored in the Corn Belt increases significantly relative to the other production areas, the volume of soybeans stored is more evenly distributed among the production regions, while wheat

[10]Storage in this model is for grain being traded in the national market.

[11]This result occurs because storage capacity is not constrained at elevators.

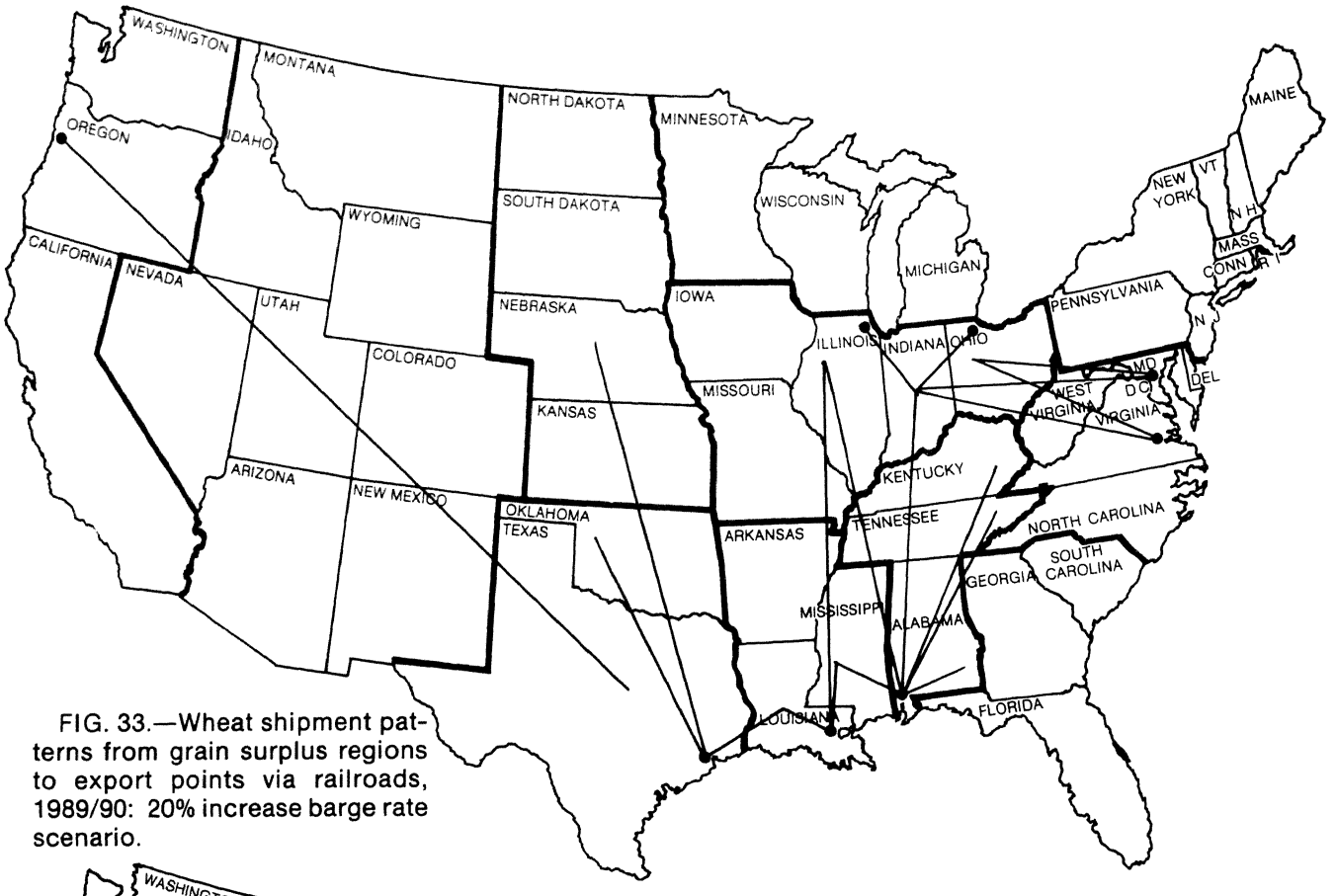

FIG. 33.—Wheat shipment patterns from grain surplus regions to export points via railroads, 1989/90: 20% increase barge rate scenario.

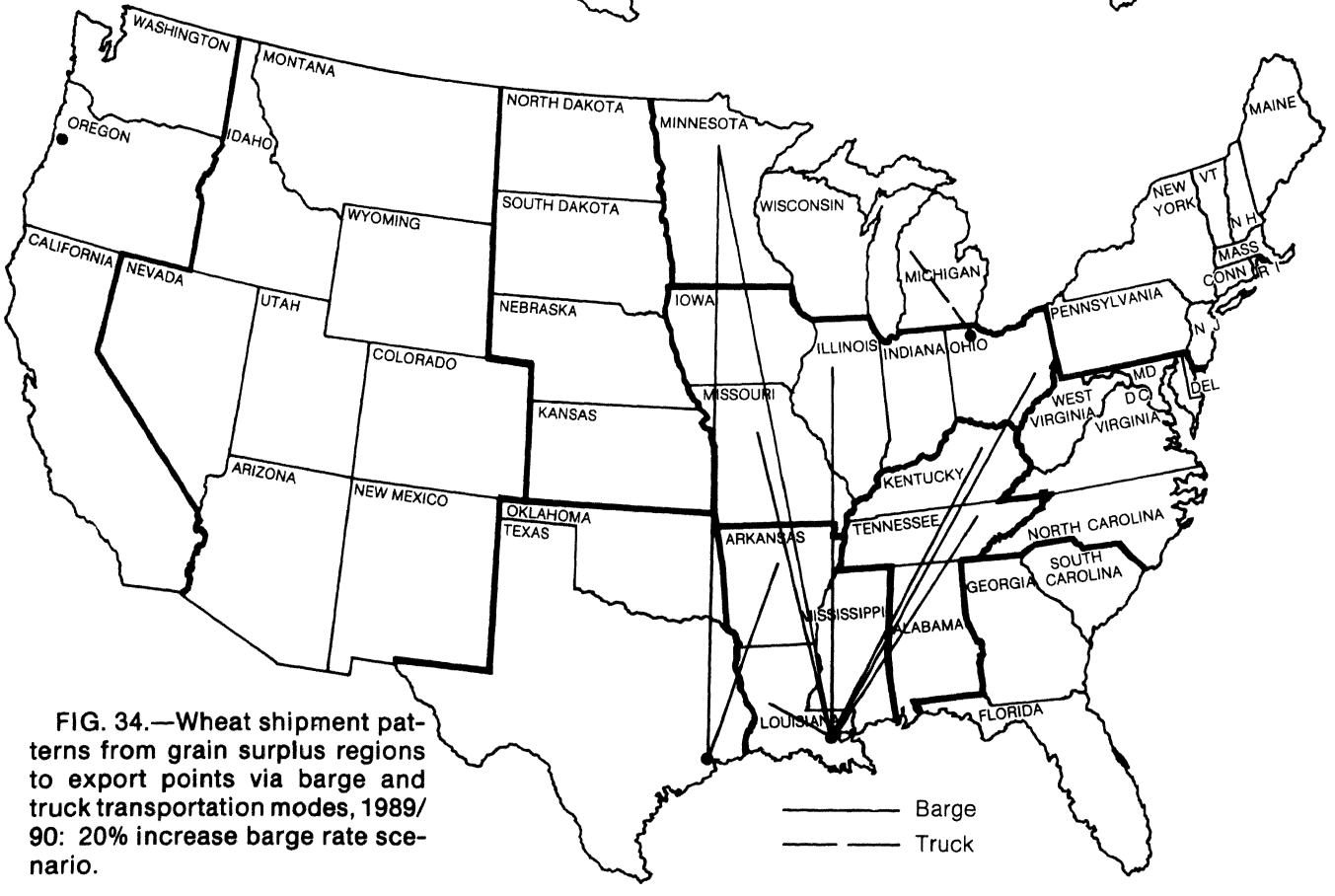

FIG. 34.—Wheat shipment patterns from grain surplus regions to export points via barge and truck transportation modes, 1989/90: 20% increase barge rate scenario.

TABLE 19.—Bushels of Grain Stored by Firms for 11 Production Regions in the U. S. and Two Time Periods, 1989/90.

Regions	Time Periods							
	July-December				January-June			
	Corn	Soybeans	Wheat	Total	Corn	Soybeans	Wheat	Total
	(Million bu)							
Baseline Estimates								
Northeast								
Mid-Atlantic		44		44		21		21
South Atlantic	2	44	2	48				
Mid-South	65	99	27	191				
Delta	4	220	32	256		13		13
Corn Belt	1,508	616	148	2,272	225	237		462
Lake States	525	33	140	698				
North Plains	519	22	570	1,111		24	262	286
South Plains	3	21	225	249		18		18
Mountain	6		2	8				
Pacific	42		30	72				
Total	2,674	1,099	1,176	4,949	225	313	262	800
Policy Scenario Increase Exports								
Northeast			3	3				
Mid-Atlantic		42		42				
South Atlantic	4	70	5	79				
Mid-South	123	168	32	323				
Delta	1	434	33	468		13		13
Corn Belt	1,972	602	166	2,740	195	220		415
Lake States	938	42	278	1,258				
North Plains	462	14	532	1,008		25	75	100
South Plains		28	296	324		31		31
Mountain	2			2				
Pacific	18		57	75				
Total	3,520	1,400	1,402	6,322	195	289	75	559
Super Port Construction								
Northeast								
Mid-Atlantic		69		69				
South Atlantic	2	62	3	67				
Mid-South	61	84	27	172				
Delta	4	250	32	286		13		13
Corn Belt	1,634	588	156	2,378	220	168		388
Lake States	494	11	153	658		10		10
North Plains	424	19	669	1,112		24	262	286
South Plains	3	17	134	154		19		19
Mountain	6		2	8				
Pacific	42			42				
Total	2,670	1,100	1,176	4,946	220	234	262	716
Pacific Coast								
Northeast						22		22
Mid-Atlantic		60		60		44		44
South Atlantic	2	47	2	51		1		1
Mid-South	65	108	27	200		13		13
Delta	1	168	32	201		159		381
Corn Belt	1,892	474	148	2,514	222	4		4
Lake States	526	149	140	815		24	262	286
North Plains	140	75	570	785		20		20
South Plains		17	225	242				
Mountain	6		2	8				
Pacific	42		30	72				
Total	2,674	1,098	1,176	4,948	222	287	262	771

TABLE 19 (Continued).—Bushels of Grain Stored by Firms for 11 Production Regions in the U. S. and Two Time Periods, 1989/90.

Regions	Time Periods							
	July-December				January-June			
	Corn	Soybeans	Wheat	Total	Corn	Soybeans	Wheat	Total
	(Million bu)							
20% Rail								
Northeast			11	11				
Mid Atlantic		81		81		22		22
South Atlantic	13	18	2	33		7		7
Mid South	65	106	39	210		3		3
Delta	16	83	26	125		10		10
Corn Belt	1,477	746	127	2,350	224	231		455
Lake States	457	33	147	637				
North Plains	469	18	504	991		24	262	286
South Plains	58	15	285	358		19		19
Mountain	7		5	12				
Pacific	42		30	72				
Total	2,604	1,100	1,176	4,880	224	316	262	802
20% Barge								
Northeast								
Mid-Atlantic		81		81		22		22
South Atlantic	2	47	2	51		44		44
Mid-South	65	107	27	199		1		1
Delta	2	243	32	277		13		13
Corn Belt	1,566	498	151	2,215	224	138		352
Lake States	519	34	140	693				
North Plains	467	74	567	1,108		96	262	358
South Plains	3	16	225	244				
Mountain	6		5	11				
Pacific	42		26	68				
Total	2,672	1,100	1,175	4,947	224	316	262	802
30% Barge								
Northeast								
Mid-Atlantic		82		82		21		21
South Atlantic	2	47	2	51		45		45
Mid-Atlantic	65	108	27	200				
Delta	2	237	32	271		13		13
Corn Belt	1,979	501	151	2,631	224	138		362
Lake States	176	33	140	349				
North Plains	397	75	567	1,039		97	262	359
South Plains	3	17	225	245				
Mountain	6		5	11				
Pacific	42		26	68				
Total	2,672	1,100	1,175	4,947	224	314	262	800
Rail Abandonment								
Northeast								
Mid-Atlantic		61		61		22		22
South Atlantic	2	61	2	65				
Mid-South	65	140	27	232				
Delta	5	284	32	321		13		13
Corn Belt	1,598	801	149	2,548	224	256		480
Lake States	435	43	138	616				
North Plains	518	24	570	1,112		24	262	286
South Plains	3	22	225	250				
Mountain	6		2	8				
Pacific	42		30	72				
Total	2,674	1,436	1,175	5,285	224	315	262	801

TABLE 19 (Continued).—Bushels of Grain Stored by Firms for 11 Production Regions in the U. S. and Two Time Periods, 1989/90.

Regions	Time Periods							
	July-December				January-June			
	Corn	Soybeans	Wheat	Total	Corn	Soybeans	Wheat	Total
	(Million bu)							
Production and Alcohol								
Northeast	7			7				
Mid-Atlantic		61		61		21		22
South Atlantic	20	61	2	83				
Mid South	81	140	27	248				
Delta	68	284	32	384		13		13
Corn Belt	2,323	801	148	3 272	224	237		461
Lake States	302	43	140	485				
North Plains	429	24	570	1,023		24	262	286
South Plains	9	22	225	256		18		18
Mountain	12		2	14				
Pacific	131		30	161				
Total	3,382	1,438	1,176	5,994	224	313	262	799
Export and Alcohol								
Northeast	7			7				
Mid-Atlantic		61		61		22		22
South Atlantic	20	61	2	83				
Mid-South	63	140	27	230				
Delta	67	284	32	383		13		13
Corn Belt	1,804	801	148	2,753	218	256		474
Lake States	211	43	140	394				
North Plains	343	24	570	937		24	262	286
South Plains	16	22	225	263				
Mountain	12		2	14				
Pacific	131		30	161				
Total	2,674	1,436	1,176	5,286	218	315	262	795
Storage								
Northeast								
Mid-Atlantic		68		68		26		26
South Atlantic	2	61	2	65		44		44
Mid-South	61	132	27	220		1	1	2
Delta	8	284	32	324		194	5	199
Corn Belt	2,341	1,033	177	3,551	1,070	649	89	1,808
Lake States	454	192	33	679	158	190	8	356
North Plains	662	97	1,060	1,819	828	97	994	1,919
South Plains	9	22	260	291		20		20
Mountain	6		2	8				
Pacific	42			42				
Total	3,585	1,889	1,593	7,067	2,056	1,221	1,097	4,374

storage by region is unchanged relative to the baseline estimate. The 30% increase in barge rates significantly increases the volume of corn stored in the Corn Belt relative to that stored in other production regions. In particular, less grain is stored in the Lake States and North Plains areas as more grain is transported by rail and less is transported by barge for this scenario. In contrast to corn, fewer bushels of soybeans are stored in the Corn Belt while wheat storage patterns among regions are nearly unchanged relative to the baseline estimate (Table 19).

The rail abandonment scenario has little effect upon the corn or wheat storage patterns among regions; however, the quantity of soybeans stored in the Corn Belt increases significantly relative to that stored in other regions (Table 19). This change occurs because more soybeans are barged to export points from the Corn Belt. For the remaining export and alcohol scenarios, the volume of corn stored in the Corn Belt again increases significantly relative to that stored in other regions. Since soybeans and wheat are not processed into alcohol, their respective storage patterns are unchanged relative to those of the baseline estimate (Table 19).

The grain stored in the second period (January to June) or the carryover into the following crop year is exogenously determined by grain supply and con-

TABLE 20.—Total Bushels of Grain Processed into Flour, Meals, Oil, and Alcohol by Region and U. S., 1989/90.

Regions	Baseline Estimate	Policy Scenarios: Increase Exports	Production and Alcohol	Export and Alcohol	All Other Policy Scenarios
			(Million bu)		
Corn					
Northeast	79	40	164	164	79
Mid-Atlantic	67		198	198	67
South Atlantic	145	51	177	177	145
Mid-South	115	36	153	153	115
Delta	185	83	186	186	185
Corn Belt			120	120	
Lake States					
North Plains			16	16	
South Plains	183	36	197	197	183
Mountain	188	48	213	213	188
Pacific	262	89	439	439	262
Total	1,224	383	1,863	1,863	1,224
Soybeans					
Northeast					
Mid-Atlantic					
South Atlantic	34	11	34	34	34
Mid-South	128	14	128	128	128
Delta	12	1	12	12	12
Corn Belt	259	101	259	259	259
Lake States					
North Plains					
South Plains					
Mountain					
Pacific					
Total	433	127	433	433	433
Wheat					
Northeast	68	17	68	68	68
Mid-Atlantic	11		11	11	11
South Atlantic	10	2	10	10	10
Mid-South	22	10	22	22	22
Delta	1		1	1	1
Corn Belt	30	25	30	30	30
Lake States	6	1	6	6	6
North Plains					
South Plains					
Mountain	11	1	11	11	11
Pacific					
Total	159	56	159	159	159
Total					
Northeast	147	57	232	232	147
Mid-Atlantic	78		209	209	78
South Atlantic	189	64	221	221	189
Mid-South	265	60	303	303	265
Delta	198	84	199	199	198
Corn Belt	289	126	409	409	289
Lake States	6	1	6	6	6
North Plains			16	16	
South Plains	183	36	197	197	183
Mountain	199	49	224	224	199
Pacific	262	89	439	439	262
Total	1,816	566	2,455	2,455	1,816

straints for the baseline estimate and the ten scenarios. Carryover for the baseline model equals 800 million bushels, of which 225 million bushels are stored corn, 313 million are soybeans, and 262 million bushels are stored wheat (Table 19). All corn carryover is stored in the Corn Belt, most of the soybeans are stored in the Corn Belt, and all of the wheat is stored in the North Plains area. All grain is stored by elevators in the area in which it is produced. Again, the reader is reminded that this stored grain represents grain in the national grain pipeline and not grain held for reserves.

Except for the storage scenario, the volume of grain stored and the storage patterns by regions for the remaining nine policy scenarios are comparable to that observed for the baseline estimate (Table 19). More grain is stored for the storage scenario; all corn is stored in the Corn Belt, North Plains, and Lake States areas; more of the soybeans are stored in the Corn Belt, while smaller quantities are stored in seven other regions; and large quantities of wheat are stored in the Corn Belt and North Plains regions. Again, the individual grains are stored in elevators within the regions in which they are produced.

Grain Processing for Baseline Estimates and Ten Policy Scenarios

The total quantity of processed grain and the quantity processed by region are exogenously determined by the constraints for the baseline model and the ten policy scenarios. Since this analysis is limited to the national grain market, the demand for processed grain does not include intraregional shipments of grain and processing demand. The reader is reminded that all intraregional shipments and other related activities ar excluded from this analysis. Thus, the bushels of grain processed into flours, meals, and oils in this national analysis are less than the total processing demand which will exist for 1989/90.

For the baseline model, 1.8 billion bushels of grain are processed into meals, flours, and/or oils. Of this total, 1.2 billion bushels of corn are processed in eight different regions, 433 million bushels of soybeans are processed into meal and oil in four different regions, and 159 million bushels of wheat are processed into flour in eight different regions (Table 20). Totals presented in this table equal those presented in Tables 2, 3, 4, and 5; however, the aggregation process used to develop Table 5 eliminates some details within regions. That is, the results in Table 20 provide more precise processing data by region.

Not surprising is the increase in the processing activity (number of bushels processed into products) when the alcohol scenarios are introduced. Further, the observed decrease in the processing activity is expected when the increased export scenario is introduced. The introduction of the remaining seven policy scenarios does not change the processing activity.

CONCLUSIONS AND IMPLICATIONS

If production and marketing trends of the last decade prevail to the 1989/90 crop year, the national grain marketing costs, transportation, storage, and firms' receiving and shipping costs in 1980 dollars may equal $5.6 billion or $0.57 per bushel of surplus grain.[12] Since record corn, soybean, and wheat harvests are estimated, the structure of the national grain industry will likely change significantly by 1989/90. More elevators and processing firms will be required and more transportation and storage facilities must be provided. The current grain receiving capacities of elevators and processors will be inadequate and transportation and storage bottlenecks will appear. Grain movements from surplus grain producing regions to grain deficit areas follow traditional grain flow patterns. Grain produced in the eastern Corn Belt (Ohio and Indiana) flows to the Northeast, the Southeast, and to the Lake, Atlantic, and Gulf ports. Grain produced in the western Corn Belt (Illinois, Iowa, and Missouri) flows to the above regions and export points and into the Southwest and Plains regions. Grain originating in the Plains areas flows West and Southwest and grain originating in the South moves to southern grain deficit regions and to the Atlantic and Gulf ports. There is no evidence from this analysis that these grain flow patterns will change; however, the introduction of a new rate structure or changes in barge traffic on alternative lines would alter this conclusion.

Rail (single car and multi-car rates) continues as the dominant transportation mode for moving grain from surplus grain producing regions to grain deficit areas. Barge traffic and train load rates, on the other hand, continue to be the dominant mode for transporting grain to export points, while truck traffic is used for short hauls to grain deficit regions and export points or is involved in transshipments of grain. These observations should be tempered by the fact that transportation services are not constrained in the model. In addition, future changes in relative rates among transportation modes will alter these findings.

All surplus grain will be stored within the regions in which it is produced. Future increases in transportation costs will ensure this finding. Since this investigation did not include federal storage subsidies (payments to farmers to store grain), farmer inconvenience cost for delivering grain to elevators at harvest time, or elevator storage constraints, nearly all of the grain is stored in elevators. The introduction of any of the above into the analysis would transfer part of the storage activity from elevators to farms.

Alternative policies do influence the decisions of investors who trade grain in the national grain market. Policies which increase the volume of exports induce investments in barge facilities relative to rail facilities and increase investments in storage facilities. Because additional bushels of grain are transshipped, invest-

[12]Other marketing costs, which are excluded from this analysis, would add significantly to the total and per unit marketing costs

ments in grain shipping and receiving capacities of elevators must increase. Although these transshipments cause total marketing costs to increase to $7.1 billion, the cost per surplus bushel decreases to $0.55. During the 1970's, policies were enacted which both expanded and embargoed exports. The nature of private investment was directed by these contradictory policies, and the performance of the national market was probably lowered as a result. If similar contradictory policies should prevail into the 1990's, investors will continue to make inappropriate decisions.

Policies which initiate the building of super ports favor investments in rail facilities relative to barge facilities. In addition, more grain is transshipped, causing firms to invest more in grain shipping and receiving capacities while investments in storage facilities are not altered. Since this policy also influences the flow of grain from surplus producing regions to both deficit regions and export points, traditional customer relationships could be disrupted by a super port policy. Since the cost in 1980 dollars of handling, transporting, and transshipping grain from surplus regions to super ports is not significantly altered relative to the cost of shipping grain to traditional smaller ports, a study is required to determine whether or not the use of large ocean-going vessels would enhance the U. S. comparative advantage in world markets.

Policies which cause grain to exit the country through West Coast ports relative to the East Coast ports stimulate investments in both rail and barge facilities, but do not change investments in storage facilities. Because large quantities of grain are transshipped and alternative transportation routes and rates are selected, marketing costs in 1980 dollars increase to $7.2 billion or $0.75 per bushel of surplus grain. The added transshipments also require additional investments in grain receiving and shipping capacities of elevators. In the anticipation of such shipments to the West Coast, new sets of train load and multi-car rates should be negotiated by firms which are located in the Corn Belt and the Plains areas.

Policies which separately and consecutively increase rail and barge rates or introduce the abandonment of rail lines do not significantly change the national marketing costs. This result from the linear programming model occurred because a transportation mode with a relatively lower rate could be substituted for a second mode where the rate had increased. However, increases in fuel prices, other transportation costs, and deregulation of the rate structure are causing all transportation rates to simultaneously increase; thus other studies are required to estimate the impact of such rate increases on U.S. marketing costs and the U.S.'s comparative advantage in the world grain market. Technical studies are also required to suggest alternative technologies for transporting grain in order to offset the upward spiral in transportation rates. To the extent that the relative rate increases in one transportation mode exceed comparable rate increases of the second mode, investment decisions to buy or rent transportation equipment will be affected, as well as locational decisions for the building of new firms.

Policies which stimulate the production of ethanol alcohol from corn also significantly increase the national marketing costs, ranging from $5.2 billion to $6.2 billion or $0.58 per bushel of surplus grain to $0.60 per bushel. The increase in costs is due in part to the increase in production of corn and the change in transportation routes and rates. These policies stimulate the demand for barge facilities relative to railroad facilities and increase the demand for storage space. Since all plants are located within regions based on a national survey rather than on economic logic, these findings may be insignificant if plants are located in other more economic regions. Additional analysis is required to determine the optimum location of alcohol plants relative to the supply of corn, transportation rates for moving corn from the surplus regions to processor demand centers, demand for alcohol, demand for distillers dried grain, and the transportation rates for moving alcohol and distillers dried grain to their final demand centers.

Policies which increase the bushels of stored grain relative to shipments of grain to demand centers require that the grain industry build more storage. In addition, the demand for all transportation modes decreases as well as the demand for receiving and shipping capacities. Finally, marketing costs decrease significantly as the added cost from the storage activities is more than offset by the decrease in transportation cost.

Based on these findings, it is obvious that the structure of the national grain industry will be significantly influenced by future policies. It is imperative that the indecisiveness and inconsistencies of the past be eliminated in order that optimum long-term investments can be made in the grain industry. For example, inconsistent poicies which stimulated exports in one period and embargoed them in another must be eliminated. Further, a national long-term storage plan and a consistent transportation policy should be developed. Finally, the decisions to process corn into alcohol should be carefully monitored and a long-term policy designed.

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